The Spine Journal 19 (2019) 1009–1018

Clinical Study

Comparison of the history and physical examination for hip osteoarthritis and lumbar spinal stenosis

James Rainville, MD[a,b,*], James V. Bono, MD[a,c], Eric B. Laxer, MD[d], David H. Kim, MD[a,c], John M. Lavelle, DO[e], Aage Indahl, MD, PhD[f,g], David G. Borenstein, MD[h], Andy J. Haig, MD[i], Jeffrey N. Katz, MD, MSc[b,j]

[a] *The Spine Center, New England Baptist Hospital,125 Parker Hill Ave, Boston, MA, USA*
[b] *Harvard Medical School, Boston, MA, USA*
[c] *Tufts University Medical School, Boston, MA, USA*
[d] *OrthoCarolina, Charlotte, NC, USA*
[e] *Tennessee Orthopaedic Clinics, Knoxville, TN, USA*
[f] *University of Bergen, Bergen, Norway*
[g] *Vestfold Hospital Trust, Stavern, Norway*
[h] *George Washington University Medical Center, Washington, DC, USA*
[i] *University of Michigan, Ann Arbor, MI, USA*
[j] *Brigham and Women's Hospital, Boston, MA, USA*

Received 14 September 2018; revised 24 January 2019; accepted 24 January 2019

Abstract

BACKGROUND: Leg pain associated with walking is sometimes incorrectly attributed to hip osteoarthritis (OA) or lumbar spinal stenosis (LSS).
PURPOSE: This study compared physicians' values of signs and symptoms for diagnosing and differentiating hip OA and LSS to their clinical utility.
STUDY DESIGN/SETTING: Musculoskeletal physicians were surveyed with online questionnaires. Patients were recruited from hip and spine specialty practices.
PATIENT SAMPLE: Seventy-seven hip OA and 79 LSS patients.
OUTCOME MEASURES: Signs and symptoms of hip OA and LSS.
METHODS: Fifty-one of 66 invited musculoskeletal physicians completed online surveys about the values of 83 signs and symptoms for diagnosing hip OA and LSS. Of these, the most valued 32 symptoms and 13 physical examination items were applied to patients with symptomatic hip OA or LSS. Positive likelihood ratios (+LR) were calculated for each items' ability to differentiate hip OA from LSS, with a +LR>2 set as indicating usefulness for favoring either diagnosis. Positive LRs were compared with surveyed physicians' values for each test.
RESULTS: All symptoms were reported by some patients with each diagnosis. Only 11 of 32 physician-valued symptoms were useful for discriminating hip OA from LSS. Eight symptoms favored hip OA over LSS: groin pain (+LR=4.9); knee pain (+LR=2.2); pain that decreased with continued walking (+LR=3.9); pain that occurs immediately with walking (+LR=2.4); pain that occurs immediately with standing (+LR=2.1); pain getting in/out of a car (+LR=3.3); pain with dressing the symptomatic leg (+LR=3.1); and difficulty reaching the foot of the symptomatic leg while dressing (+LR=2.3). Three symptoms favored LSS over hip OA: pain below the knee (+LR=2.3); leg tingling and/or numbness (+LR=2.7); and some pain in both legs (+LR=2.5). Notable symptoms that did not discriminate hip OA from LSS included: pain is less while pushing a shopping cart (+LR=1.0); back pain (+LR=1.1); weakness and/or heaviness of leg (+LR=1.1);

FDA Device/Drug Note: Not applicable.

Author disclosures: ***JR***: Grant: Michael Wall Charitable Trust: (D, paid directly to institution). Royalties: Harvard Online CME (A), UpToDate (A); ***JVB***: Royalties: Stryker (G), Springer Verlag (B), Sectra (F). Consulting: Stryker (E). ***EBL***: Royalties: Cutting Edge Spine (none). Fellowship Suppport: NuVasive (F, paid directly to institution). ***DHK***: Consulting: Pacira Pharma (B), Convatec (B), Micro-Medicine (B). Speaking/Teaching Arrangements: Convatec (B). Scientific Advisory Board/Other Office: Bioventus (D), Intrinsic Therapeutics (D). ***JML***: Nothing to disclose; ***AI***: Nothing to disclose; ***DGB***: Nothing to disclose; ***AJH***: Nothing to disclose; ***JNK***: Nothing to disclose.

* Corresponding author. The Spine Center, New England Baptist Hospital, 125 Parker Hill Ave, Boston, MA 02120, USA. Tel.: (617) 754-5246; fax: (617) 754-6332.

E-mail address: jrainvil@nebh.org (J. Rainville).

https://doi.org/10.1016/j.spinee.2019.01.006

buttocks pain (+LR=1.2); poor balance or unsteadiness (+LR=1.2); pain that increased with weight-bearing on the painful leg (+LR=1.3), and step to gait on stairs (+LR=1.7). Consistent with physicians' expectations, 7 of 13 physical examination items strongly favored hip OA over LSS: limited weight-bearing on painful leg when standing (+LR=10); observed limp (+LR=9); and painful and restricted range-of-motion with any of five hip maneuvers (+LR range 21−99). Four of five tested neurological deficits (+LR range 3−8) favored the diagnosis of LSS over hip OA.

CONCLUSIONS: There is substantial crossover of symptoms between hip OA and LSS, with some physician-valued symptoms useful for differentiating these disorders whereas others were not. Physicians recognize the value of the examination of gait, the hip, and lower extremity neurological function for differentiating hip OA from LSS. These tests should be routinely performed on all patients for which either diagnosis is considered. Awareness of these findings might reduce diagnostic errors.

Keywords: Assessment; Hip osteoarthritis; History; Lumbar spinal stenosis; Physical examination; Symptoms

Introduction

Proximal leg pain with or without radiation below the knee that is induced by walking and relieved with sitting is sometimes mistakenly attributed to lumbar spinal stenosis (LSS) when the cause is actually hip osteoarthritis (OA), and vice versa, with understandable consequences for misdiagnosed patients [1−5]. It is probable that a combination of epidemiological and clinical factors contributes to diagnostic errors between hip OA and LSS. Imaging studies have demonstrated that both conditions have substantial prevalence in adults over the age of 50 [6−11] and therefore, hip OA and LSS can exist concurrently [5,12−15]. Both conditions typically develop gradually and can be present on imaging for many years in asymptomatic individuals [6−11]. Thus, imaging findings alone cannot establish either diagnosis but instead must be correlated with the results from the history and physical examination. It is at this essential step that most diagnostic errors likely occur.

There are a number of reasons for this. First, both conditions frequently present with the complaint of leg pain induced by walking and relieved with sitting [5,16,17]. Though both conditions have typical pain locations, both can produce pain in atypical areas that can mimic the other disorder [18−23]. Both conditions have a variety of symptom patterns believed to support their diagnosis, such as temporal associations of pain onset with walking, factors that alleviate symptoms, and nonwalking activities that induce pain [24−26]. However, the accuracy of these symptom patterns and their ability to differentiate hip OA and LSS are not established. Both conditions have physical examination findings of diagnostic value [23,27−33] but even here crossover exists [34]. As the clinical evaluation likely contributes to diagnostic error, improved understanding of the strengths and weakness of the history and physical examination items commonly employed by musculoskeletal physicians may be useful for reducing diagnostic error [3,4,25,35,36].

We hypothesized that direct comparisons of history and physical examination items commonly used to assess patients suspected of having symptomatic hip OA or LSS would identify items that may contribute to diagnostic errors. The first step was to determine the values that musculoskeletal physicians place on specific signs and symptoms for diagnosing and differentiating hip OA and LSS. The second step was to test the accuracies of clinical signs and symptoms most valued by musculoskeletal physicians to diagnose and differentiate hip OA and LSS in patients with these diagnoses. The third step was to compare the values that musculoskeletal physicians assign to clinical signs and symptoms with their accuracies in patients with these disorders to identify those that may be overvalued or undervalued by physicians and contribute to diagnostic error.

Methods

Survey of musculoskeletal physicians

For the first step of this study, a questionnaire was developed to assess the values that musculoskeletal physicians gave to items of the clinical examination for diagnosing hip OA and LSS. Eighty-three items (35 clinical signs and 48 symptoms) reported to have diagnostic value for hip OA and LSS were assembled from a review of medical literature [3,4,18−34]. These items were organized into nine topic-focused questionnaires using SurveyMonkey (San Mateo, CA, USA). Questionnaires asked musculoskeletal physicians to rate the value of each item for diagnosing hip OA and LSS. Responses were reported using Likert scales with anchors: 1-Strongly Refutes Diagnosis; 5-Uncertain Value; and 9-Strongly Supports Diagnosis [37]. Invitations to complete these questionnaires were sent via email to 66 musculoskeletal physicians (20 hip surgeons, 17 spine surgeons, 12 rheumatologists, and 17 physiatrists) that were institutional colleagues or academic acquaintances of the authors. We chose to survey physicians from four disciplines that see musculoskeletal disorders as we theorized that this would best assess the diagnostic values attributed to these items by musculoskeletal physicians in general. Weekly emailed reminders to complete questionnaires were sent to all physicians.

Construction of patient questionnaire

Clinical items that musculoskeletal physicians rated most useful for diagnosing hip OA and LSS were defined as items that 70% of musculoskeletal physicians scored 7−9 (supports the diagnoses of hip OA or LSS), and those items for which 70% scores of 1−3 (refutes these diagnoses) [37]. These items were assembled into the questionnaire administered to patients with symptomatic hip OA or LSS. Additionally, items outside these criteria for which mean scores for hip OA and LSS differed by ≥1.5 were added to the questionnaire, as these items may have value for differentiating these diagnoses.

Recruitment of patients

For the second step of this study, a cohort of patients with symptomatic hip OA or LSS were asked to complete the questionnaires. The cohort was assembled through a convenience sample of patients from 2 spine surgery practices, 2 joint arthroplasty practices, and 1 hospital-based spine center. Enrolling physicians had between 13 and 25 years of subspecialty experience with these types of patients.

Inclusion criteria were: (1) primary symptom of proximal leg pain with or without radiation below the knee induced with walking and relieved by sitting, with or without buttock, hip or distal leg pain; and (2) image confirmed hip OA or LSS determined by the enrolling physician to be the cause of these symptoms. Criteria 1 was chosen to focus enrollment to patients with the primary symptom that is common to both disorders, as misinterpretation of the nuances of this symptom was suspected to be a potential source of diagnostic error. Criteria 2 was chosen to insure we only analyzed clinical findings of patients that truly had either diagnosis following consideration of all factors related to that case by the enrolling physician. We included patients with symptomatic hip OA but concurrent asymptomatic LSS, and vice versa only if there was strong evidence, based on the physical examination results from additional diagnostic test, and responses to therapeutic interventions that only one disorder was responsible for current symptoms. When concurrent hip OA and LSS were present, the diagnosis of symptomatic hip OA required limited and painful hip range-of-motion (ROM) along with hip arthrogram with local anesthetic immediately relieved pain with walking, and the diagnosis of symptomatic LSS required that hip arthrogram did not improve symptoms [38].

Exclusion criteria were: (1) leg pain that was not induced by walking and relieved with sittings; (2) painless presentations of hip OA (restricted ROM only) and LSS (neurological symptoms only); (3) prior unsuccessful hip or spine surgery for current symptoms; and (4) lack of proficiency in English language or cognitive limitations that resulted in the inability to independently complete the study questionnaire. Recruited patients were withdrawn if after additional evaluation it was concluded that: (1) they had concurrent symptomatic hip OA and symptomatic LSS; (2) the recruiting physician was unsure of the diagnosis; (3) other diagnoses were found to be the cause of symptoms.

Potential study patients were informed that participation was voluntary and would not influence their medical care. Interested patients signed an informed consent that was approved by investigational review boards of the affiliated institutions.

Patient assessment

Patients completed a questionnaire that inquired about demographics and history of symptoms. A pain impact score was generated with items selected from the 29-item Patient-Reported Outcome Measurement Information System (PROMIS) Short Form, that included pain intensity (0−10 visual analog scale), pain interference with normal activities (four items), and functional status (four items) [39]. Because PROMIS is valid across different medical disorders, its use allowed us to assess the disease impact for hip OA and LSS with a single measure [40]. The patient questionnaire included 32 symptoms derived from the responses of musculoskeletal physicians. Pain locations and neurological symptoms were offered "Yes" or "No" responses. Items assessing the association of symptoms with daily activities were offered responses of "Yes," "No" or "Not Sure" as some items may have inquired about activity that were outside some patients' experiences.

For each patient, the enrolling physicians completed questionnaires that included 13 physical examination items. Items pertaining to hip ROM were offered responses of "Pain Free" or "Painful" and "Normal" or "Restricted" as compared with the asymptomatic hip. For primary analyses, hip examination findings were combined as "Painful and Restricted" or "Neither Painful nor Restricted." Other physical examination tests offered responses of "Yes" if present, "No" if absent, or "Not Tested." Results from hip imaging were coded as "None/Doubtful Hip OA," "Mild Hip OA," or "Moderate/Severe Hip OA" using a modified Kellgren-Lawrence scale [41]. Results from lumbar MRI/CT were recorded as "No LSS," "Grades 1," "Grade 2," or "Grade 3" based on the percent of reduction of spinal canal area [42]. Results of additional diagnostic and therapeutic procedures (hip arthrogram, electrodiagnostic tests, and lumbar steroid injection) were reported as to whether they supported or refuted the targeted diagnosis. Additional diagnostic studies or procedures were acquired only for purposes of patient care, and not solely for this study. Finally, recruiting physicians offered their final diagnosis by selecting one of the following: (1) Hip OA; (2) LSS; (3) Concurrent Symptomatic Hip OA and LSS; (4) Unsure; or (5) Other condition.

Statistical methods

SPSS for Windows (IBM, Armonk, NY, USA) was used for data analysis. Wilcoxon signed-ranked test was used to

compare the experts' scoring of clinical items for diagnosing hip OA and LSS. The clinical characteristics of patients with hip OA and LSS were compared using chi-square for categorical variables, student t-test for numeric variables and Wilcoxon signed-ranked test for ranked variables. The diagnosis as established by the recruiting physician was the standard against which clinical items were evaluated. The sensitivities of signs and symptoms and positive likelihood ratios (+LR) for each disorder versus the alternative diagnosis were calculated using 2×2 tables [43]. Positive LR reflects the ratio of the sensitivity of each clinical item for hip OA and LSS, with the higher sensitivity the numerator and the lower sensitivity the denominator. As an approximation, +LR with values of 2, 5, and 10 increase the pretest probability of a diagnosis about 15%, 30%, and 45% [44].

Step 3 was accomplished by comparing the differences in sensitivity and the +LR of each item for diagnosing hip OA and LSS with musculoskeletal physicians' reported values for differentiating these diagnoses.

Sample size calculations were based on z statistic to compare proportions of dichotomous variables between those with hip OA and LSS. It was postulated that the frequency of a high value association of an item with a diagnosis should be $\geq$50%, whereas its association with the alternative diagnosis should be $\leq$25%, resulting in a difference of 25%. A two-tailed α was set at 0.05, whereas β was set at 0.10, producing a sample size of 77 subjects per diagnosis [45].

Results

Fifty-one of 66 invited musculoskeletal physicians completed the online questionnaires (78% response rate). This included 11 hip surgeons, 13 spine surgeons, 10 rheumatologists, and 17 physiatrists. Responders had a mean of 16 years of practice experience and saw an average of 51 (standard deviation, 35) hip OA and/or LSS patients per month.

Based on inclusion criteria, 28 of the 48 symptoms were included in the patient questionnaire. The authors chose to retain the symptom "pain in the knee" that was outside these criteria because this symptom had been reported as common in hip OA [21,22] and we had no knowledge of its occurrence in LSS. Additionally, three items were added per suggestions of surveyed musculoskeletal physicians: pain in outer hip; difficult to reach the foot of painful leg when dressing, and pain climbing stairs. Thirteen of 35 physical examination items were retained for the patient physical examination. Among surveyed musculoskeletal physicians, only five of 23 neurological examination items were considered of value for diagnosing LSS.

Seventy-seven patients with hip OA and 79 with LSS participated in this study. Fig. 1 presents a summary of patient recruitment and withdrawal. Hip OA and LSS patients' characteristics are reported in Table 1, and diagnostic tests results in Table 2. A minority of patients had both hip and lumbar spine imaging, and for this subgroup, simultaneous occurrence of anatomic but asymptomatic hip OA or LSS was modest (Table 2). Positive responses to hip arthrogram supported the diagnosis of hip OA in half of the patients with hip OA, and positive responses to lumbar injections supporting the diagnosis of LSS in most of the patients with LSS (Table 2).

Table 3 presents the distribution of symptoms reported by patients with hip OA or LSS, along with the values given by musculoskeletal physicians for these symptoms.

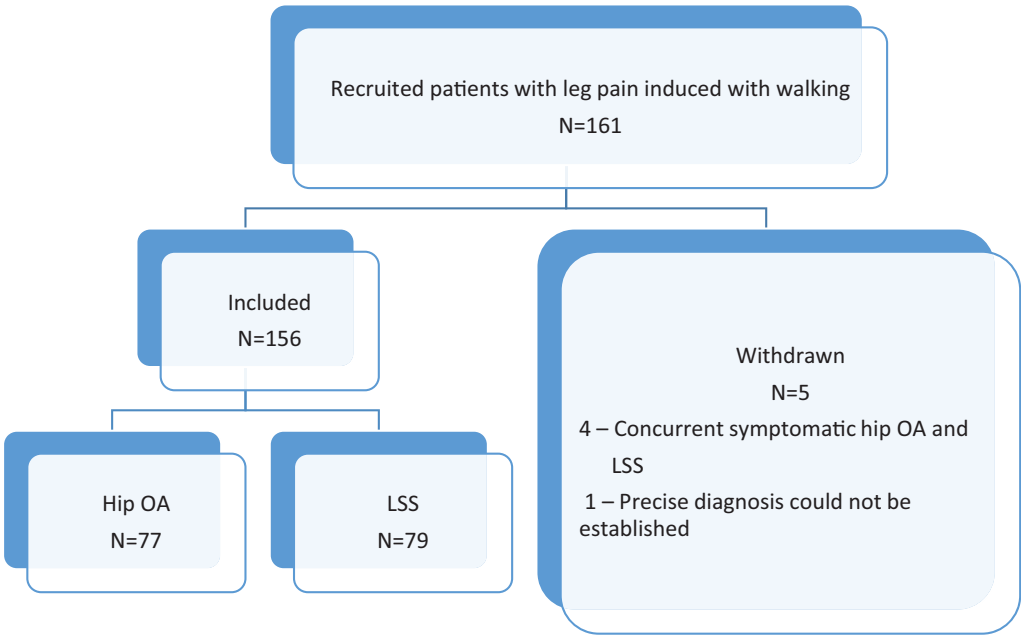

Fig. 1. Summary of recruitment and withdrawal of subjects.

Table 1
Characteristics of patients with hip OA and LSS

	HIP OA N=77 Mean (SD)	LSS N=79 Mean (SD)	p*
Age (years)	64 (10)	69 (9)	.001
Body mass index (kg/m^2)	28 (6)	28(6)	N.S.
PROMIS pain impact measures			
Pain intensity (0-10)	6.4 (1.8)	6.4 (1.8)	N.S.
Pain Interference (1–5)			
Day to day activities	3.6 (.9)	3.3 (1)	N.S.
Working around the house	3.4 (1.1)	3.2 (1.1)	N.S.
Social activities	3.1 (3.9)	2.9 (1.3)	N.S.
Household chores	3.4 (1.1)	3.1 (1.3)	N.S.
Interference score (4–20)	13 (4)	12 (4)	N.S.
Function (1–5)			
Walk a block	2.8 (1.2)	2.8 (1.2)	N.S.
Walk 15 minutes	3.2 (1.1)	3.4 (1.3)	N.S.
Run errands or shop	2.8 (1.0)	2.6 (1.0)	N.S.
Walk to do chores	3.4 (1.1)	3.3 (1.2)	N.S.
Function score (4–20)	12.8 (3.7)	12.1 (3.8)	N.S.
Pain Impact Score (8–50)	32.6 (8.2)	30.9 (8.2)	N.S.
	Percent	**Percent**	**p†**
Female/male	60/40	41/59	.02
White race	97	94	N.S.
College or advanced degree	76	74	N.S.
Never smoked	62	53	N.S.
Daily medications for pain			
NSAID	66	53	N.S.
Acetaminophen	33	27	N.S.
Muscle relaxants	5	6	N.S.
Opioids	12	18	N.S.
Gabapentin/pregabalin	5	13	N.S.
Prior physical therapy	57	70	N.S.
Frequency of pain with walking			N.S.
Every time	69	58	
Every day, not every time	25	32	
Most days	6	8	
Weekly	0	1	
Less than weekly	0	1	
Duration of symptoms >6 month	78	87	N.S.
	Mean (SD)	**Mean (SD)**	**p***

N, number of subjects; SD, standard deviation; NSAID, Non steroidal anti-inflammatory drug; PROMIS; Patient-Reported Outcome Measurement Information System.

* Student t-test or Mann-Whitney test.

† Chi square or Fisher Exact test.

Table 2
Summary of diagnostic test for patient with hip osteoarthritis (Hip OA) and lumbar spinal stenosis (LSS)

	Hip OA N=77 Percent	LSS N=79 Percent
Hip radiograph	100	24
Hip MRI	14	1
Hip CT	4	0
Results for those with hip imaging		
No hip OA	0	65
Mild hip OA	10	30
Moderate/severe hip OA	90	5
Anesthetic hip arthrogram	44	5
Arthrogram improved leg pain	100	0
Lumbar MRI	42	99
Lumbar CT	1	1
Results for those with lumbar imaging		
No LSS	43	0
Grade 1 LSS	17	6
Grade 2 LSS	27	22
Grade 3 LSS	13	72
Epidural Steroid Injection	14	67
Epidural improved leg pain	0	94

N, number of subjects; MRI, magnetic resonance imaging; CT, computer tomography.

Comments are offered concerning physicians' value ratings compared with findings in patients. Seven symptoms favored hip OA over LSS (+LR>2): groin pain; knee pain; pain that decreased with continued walking; pain that occurs immediately with standing; pain getting in/out of car; pain dressing the symptomatic leg; and difficult to reach the foot of painful leg when dressing. Three symptoms favored LSS over hip OA (+LR>2): leg tingling and/or numbness; some pain in both legs; and pain below the knee. Many symptoms were equally common in hip OA and LSS, including back pain, buttock pain, pain climbing stairs, weakness and/or heaviness of legs, and pain is less while pushing a shopping cart.

Table 4 presents the physical examination findings for patients with hip OA or LSS, along with the values given by musculoskeletal physicians for those findings. Restricted and painful hip ROM was diagnostic of hip OA and strongly differentiated hip OA from LSS (+LR range, 21–99). At least one painful and limited hip maneuver was present in all but 2 patients with hip OA, one with painful but not restricted hip ROM and the other with restricted but pain free hip ROM during all hip maneuvers. For both, hip arthrogram with local anesthetic temporarily eliminated all leg pain symptoms with walking. In contrast, only 9% of those with LSS had any hip maneuver that was painful and limited. At least one lower extremity neurological deficit was found in 39% of patients with LSS and 20% of those with hip OA (Chi 7.32, p=.007).

Discussion

This study attempted to clarify the utility of commonly assessed clinical items for diagnosing hip OA and LSS, and for differentiating these disorders. Comparisons between the discriminating ability of clinical items derived from patients and the value placed on these items by surveyed musculoskeletal physicians is a unique contribution of this study and highlights the strengths and weaknesses of physicians' assumptions about the clinical characteristics of these diagnoses that may prevent or contribute to diagnostic errors. Our findings revealed substantial overlap of symptoms between these disorders and draw attention to the need for physicians to maintain a degree of diagnostic uncertainty until both diagnoses has been fully considered.

Table 3
Symptoms associated with hip osteoarthritis (Hip OA) and lumbar spinal stenosis (LSS). Patient reported symptoms are for 77 patients with Hip OA and 79 patients with LSS. Sensitivity reflects the frequency of symptoms with each disorder, whereas differences in sensitivity and positive likelihood ratios if greater that 1 (+LR≥1.0) reflect their potential values for favoring one disorder over the other. Physicians' mean values for symptoms are based on responses of 51 surveyed musculoskeletal physicians to questionnaires that scored each item using 1-9 Likert scales (1"Strongly refutes diagnosis", 5 "Uncertain value", and 9 "Strongly supports diagnosis"). Differences in mean scores reflect potential value physicians may give to symptoms for differentiate these disorders

	Patient reported symptoms					Physicians' value for symptoms			
	Sensitivity			+ LR if ≥1.0		Mean diagnostic value (1−9)			Comments about physicians' value compared with diagnostic value of symptoms
Symptoms	Hip OA	LSS	Difference	Hip OA	LSS	Hip OA	LSS	Difference	
Locations of pain with walking									
Groin	.63	.13	.49†	4.9		8.2	3.5	4.7‡	Recognized as favoring hip OA
Side of hip	.83	.50	.33†		1.7	–	–	–	Item suggested by several surveyed physicians
Below knee	.25	.57	.32†		2.3	2.5	7.7	5.2‡	Recognized as favoring LSS
Knee	.56	.26	.30†	2.2		5.5	5.0	0.5	Value for hip OA underestimated
Front of thigh	.61	.33	.28†	1.9		6.6	5.0	1.6	Anterior thigh pain twice as common in hip OA
Side or back of thigh	.43	.60	.17		1.4	4.3	6.5	2.2‡	Weakly differentiates hip OA and LSS. May be overvalued as suggestive of LSS
Both legs	.09	.22	.13		2.5	3.0	7.5	4.5‡	Uncommon in either disorder. Recognized as favoring LSS
Buttock	.56	.68	.12		1.2	4.7	6.6	2.1‡	Present in half of patients with Hip OA
Low back	.57	.65	.08		1.1	3.4	6.1	2.7‡	Present in half of patients with hip OA. May be overvalued for refuting diagnosis of hip OA
Neurological symptoms									
Leg tingling or numbness	.23	.67	.45†		2.7	2.6	7.8	5.2‡	Recognized as strongly favoring LSS
Poor balance or unsteadiness	.52	.43	.09	1.2		4.4	6.4	2.0‡	Frequency in hip OA may be underappreciated. Does not differentiate hip OA and LSS
Leg weakness or heaviness	.62	.57	.05	1.1		4.4	7.3	2.9‡	Frequency in hip OA may be underappreciated. Does not differentiate hip OA and LSS
Symptom patterns with walking									
Pain occurs immediately with walking	.74	.31	.43†	2.4		6.8	4.5	2.3‡	Recognized as favoring hip OA
Pain causes a limp	.87	.53	.35†	1.7		7.5	4.6	2.9‡	Recognized as favoring hip OA, but also common in LSS
Pain is worse when bearing weight on painful leg	.87	.63	.24*	1.3		7.4	3.9	3.5‡	Frequency in LSS may be underappreciated. Does not strongly differentiate hip OA and LSS
Pain occurs only after walking a period of time	.30	.54	.24*		1.8	4.9	7.3	2.4‡	Recognized as favoring LSS
Pain increases with continued walking	.81	.77	.04	1.0		6.2	7.1	0.9	Recognized as equally common in both disorders
Actions that relieve leg pain induced by walking									
Pain is relieved by stopping and squatting	.10	.30	20*		1.7	3.4	6.5	3.1‡	Uncommon in either diagnosis, but recognized as favoring LSS. (31% of patients reported unsure)
Pain will decrease with continued walking	.20	.5	.15	3.9		4.5	2.9	1.6‡	Uncommon in either diagnosis, but when present, recognized as favoring hip OA
Pain improves with sitting	.75	.90	.14		1.1	6.4	7.4	1.0	Recognized as associated with both disorders
Pain improves by stopping and bending forward at the waist	.40	.54	.14		1.5	3.8	7.8	4.0‡	May be overvalued as diagnostic of LSS. (24% of patients reported unsure)
Pain is less when pushing a shopping cart	.77	.80	.03		1.0	5.0	7.8	2.9‡	Recognized as valuable symptoms of LSS, but equally common in hip OA. Does not differentiate these disorders
Symptom patterns with standing									
Standing immediately induces pain	.49	.23	.26*	2.1		6.4	4.9	1.5‡	Recognized as slightly more diagnostic of hip OA.
Standing induces pain only after a period of time	.47	.63	.16	1.4		5.3	6.7	1.4‡	Recognized as slightly more diagnostic of LSS
Cannot stand up straight because of pain	.46	.41	.5	1.2		5.2	7.1	1.9‡	May be overvalued for LSS. Equally common in both disorders

Table 3 (*Continued*)

Symptoms	Patient reported symptoms					Physicians' value for symptoms			Comments about physicians' value compared with diagnostic value of symptoms
	Sensitivity			+LR if ≥1.0		Mean diagnostic value (1−9)			
	Hip OA	LSS	Difference	Hip OA	LSS	Hip OA	LSS	Difference	
Association of leg Pain with specific activities									
Getting in and out of car induces leg pain	.90	.24	.66†	3.8		7.3	3.5	3.8‡	Recognized as having high diagnostic value for hip OA
Dressing the symptomatic leg induces leg pain	.79	.25	.54†	3.1		7.3	3.7	3.9‡	Recognized as having high diagnostic value for hip OA
When dressing, it is difficult to reach the foot of painful leg	.84	.37	.47†	2.3		–	–	–	Item suggested by several surveyed physicians
Painful to climb Stairs	.86	.49	.37†	1.7		-	–	–	Reported by most people with hip OA and half of those with LSS. (Item miss printed in online survey)
Going from sit to stand induces leg pain	.77	.44	.33†	1.8		6.5	4.6	1.9	Frequency in hip OA may be underappreciated
Must climb stairs on step at a time (step-to gait)	.63	.39	.24*	1.6		6.5	5.0	1.5‡	Recognized as more useful in hip OA
Leg pain induced when first standing in morning	.70	.57	.13	1.2		6.3	4.6	1.7	Common in both disorders

* $p \leq .01$
† $p \leq .001$ Chi square for differences in frequency of finding (sensitivity) between Hip OA and LSS.
‡ $p \leq .01$ Wilcoxon signed rank test for differences in response scores between Hip OA and LSS.

Many of our findings, such as the most common pain locations for hip OA and LSS, confirm those of past research [19−23]. When comparing pain locations between disorders, groin pain had the highest +LR of all history items, and this was appreciated by surveyed physicians. Surveyed physicians overvalued pain below the knee, and back pain as symptoms refuting the diagnosis of hip OA. We found that pain below the knee was reported by one quarter of patients with hip OA, thus confirming the findings of Lesher et al. [22]. We also confirmed Wolfe's findings that back pain is reported by half of patients with hip OA [19] and cannot be used to differentiate between these disorders. In this study, knee pain was more common among patients with hip OA than reported by previous studies [17,22], and we found that knee pain was much less common in LSS. Thus, knee pain may have value for differentiating hip OA from LSS. Surveyed physicians may overvalue unsteadiness, and leg weakness and/or heaviness for favoring the diagnosis of LSS, as we recorded these complaints were equally common in patients with hip OA. Surveyed physicians correctly opined that leg tingling and numbness were more likely in LSS. Consistent with classic descriptions of symptom patterns and the opinions of surveyed physicians, delayed onset of leg pain with walking was found to favor LSS, whereas immediate onset of pain with walking favored hip OA, but neither to the degree that they were of high value for excluding the alternative diagnosis.

In terms of items related to factors that alleviated walking-induced leg pain, several interesting findings were observed when comparing physician opinions and actual patient-reported responses. Though an infrequently reported symptom pattern, leg pain that lessened with continued walking favored hip OA over LSS, and the discriminating value of this symptom may be underappreciated by physicians. Physicians valued leg pain that lessened by bending forward at the waist as supporting the diagnosis of LSS, but this was nearly as common in patients with hip OA. Physicians valued pain that is less while pushing a shopping cart but this classic symptom actually demonstrated no ability to discriminate LSS from hip OA.

Pain symptoms induced during specific activities that place mechanical stress on the symptomatic leg were reported by most patients with hip OA. Pain with getting in and out of a car, and pain with dressing the symptomatic leg were very common in hip OA and had modest ability to differentiate hip OA from LSS. The discriminating powers of these items were recognized by physicians. However, pain with climbing stairs, must climb stairs one step at a time, and pain with transitioning from sit to stand, though also reported by most patients with hip OA, were almost as common in patients with LSS and therefore of limited value for differentiating hip OA from LSS.

The results from the physical examination confirmed the opinions of our surveyed physicians that limited and painful hip ROM was the cardinal sign of hip OA [31] with very

Table 4
Physical examination findings associated with hip osteoarthritis (Hip OA) and lumbar spinal stenosis (LSS). Physical examination findings are for 77 patients' with Hip OA and 79 patients with LSS. Sensitivity reflects the frequency of findings with each disorder, whereas differences in sensitivities and positive likelihood ratios if greater than 1 (+LR≥1.0) express their potential values for favoring on disorder over the other. Physicians' mean values for findings are based on responses of 51 surveyed musculoskeletal physicians to questionnaires that scored each item using 1−9 Likert scales (1 "Strongly refutes diagnosis", 5 "Uncertain value", and 9 "Strongly supports diagnosis"). Differences in mean scores reflect potential value physicians may give to symptoms for differentiate these disorders

	Physical examination finding					Physicians' value for finding			
	Sensitivity			+ LR if ≥1.0		Mean diagnostic value (1−9)			Comments about physicians' value compared with diagnostic value of finding
Symptoms	Hip OA	LSS	Difference	Hip OA	LSS	Hip OA	LSS	Difference	
Hip examination[†]									
Internal rotation restricted and painful	.92	.04	.88[‡]	24.0		8.2	4.2	4.0[§]	Physicians recognized painful and limited hip range of motion as diagnostic of hip OA, but may undervalue the rarity of these findings in LSS
FADIR restricted and painful	.84	.03	.81[‡]	33.0		7.4	4.4	3.0[§]	As above
Flexion restricted and painful	.75	.00	.75[‡]	99.0		8.1	3.9	4.2[§]	As above
FABER restricted and painful	.78	.04	.74[‡]	21.0		7.0	4.3	2.7[§]	As above
External rotation restricted and painful	.69	.00	.69[‡]	99.0		7.4	4.2	3.2[§]	As above
Posture and gait									
Walks with a limp	.87	.10	77[‡]	9.0		7.1	4.9	2.2[§]	Recognized as finding that is diagnostic of hip OA
Shifts weight away from painful leg when standing	.69	.07	62[‡]	10.0		6.9	4.7	2.2[§]	Recognized as finding that is diagnostic of hip OA
Bends forward at waist when walking	.36	.37	.01		1.1	5.1	7.1	2.0[§]	Diagnostic value for LSS may be overestimated. Does not differentiate Hip OA and LSS
Neurological examination									
Extensor hallicus longus weakness	.03	.23	.20		8.0	3.6	6.6	3.0[§]	Infrequent finding. When present, recognized as favoring LSS
Diminished pin prick in lower extremity dermatome	.04	.19	.15		5.0	4.0	6.8	2.8[§]	Infrequent finding. When present, recognized as favoring LSS
Ankle dorsiflexion weakness	.03	.13	.10		3.0	3.6	6.6	3.0[§]	Infrequent finding. When present, recognized as favoring LSS
Straight-leg-raising reproduces symptoms	.03	.06	.03		2.3	3.9	6.1	2.2[§]	Uncommon in both disorders. When present, recognized as favoring LSS
Ankle plantarflexion weakness	.07	.09	.02		1.3	3.6	6.6	3.0[§]	Uncommon in both disorders. When present, does not favor LSS

FADIR, Hip flexion, adduction and internal rotation.
FABER, Hip flexion, abduction and external rotation.
[†] Hip examination done in supine posture. Internal and external rotation evaluated with hip at 90 degrees flexion.
[‡] $p \leq .001$ Chi square for differences in frequency of finding (sensitivity) between Hip OA and LSS.
[§] $p \leq .01$ Wilcoxon signed rank test for differences in response scores between Hip OA and LSS.

large +LRs for all hip maneuvers. The magnitude of these differences supports the notion that for all patients with suspected LSS examination of the hip is essential to rule out unsuspected symptomatic hip OA. Physicians correctly opined that walking with a limp and reduced weight bearing on symptomatic leg strongly support the diagnosis of hip OA over LSS. Although neurological deficits were infrequent findings, their presence supported the diagnosis of LSS, as physicians expected.

This study has several strengths. All clinical data was collected prospectively with symptoms reported directly by patients and not as recorded in the medical records by medical providers. This allowed for direct comparisons of multiple clinical items between these diagnoses, including items that are typically assessed for one diagnosis and not the other. Also, by using a patient-completed questionnaire, we avoided verification bias by the enrolling physician that might have favored recording of positive clinical findings that support their working diagnoses [46,47]. Additionally, both groups of patients reported similar pain and functional impact of their problems, suggesting that our comparison between these disorders was made at similar stages of disease impact from these disorders.

The limitations of this study are clearly recognized, as the validity of all comparisons rest on two assumptions. The first assumption is that our surveyed hip surgeons, spine surgeons, rheumatologist, and physiatrists are representative of musculoskeletal physicians in general. This assumption is supported by the many years of experience and substantial monthly exposure to hip OA and LSS by those who completed this survey. The second assumption is that patients were correctly diagnosed by the enrolling physician, as their clinical opinion was the standard for calculations of sensitivities and +LR. The enrolling physicians were all experienced academic experts in hip OA or LSS, and all patients were vetted for the alternative diagnoses by the process of participating in the study. Though the possibility of incorrect diagnosis still exists, it is lessened by the requirements for establishing the final diagnosis, including the structured clinical assessment, positive findings on imaging, and, when needed, confirmatory hip arthrograms, and lumbar injections used to support the diagnosis [37]. Only one-third of study patients had imaging of both the hips and lumbar spine, and compatible with prior studies, about a third of these patients were found to have concurrent anatomic hip OA and LSS [5,12–15,35]. The concurrent anatomic diagnosis was assumed to be asymptomatic based on an unremarkable clinical assessment for that diagnosis, along with lack of response to diagnostic hip arthrogram or lumbar injections when indicated. It is statistically likely that some of the two-thirds of patients without imaging of both the hip and spine also had undetected coexisting hip OA and LSS. This was unavoidable, as the protocol for this study required that imaging could not be acquired solely for the purposes of this study but only for clinical decision making. Regardless, it is possible that some cases of unrecognized concurrent symptomatic hip OA and LSS might have contributed to symptoms that had been incorrectly classified as related to only one clinical diagnosis.

In summary, many clinical items have diagnostic value for differentiating hip OA from LSS in patients presenting with symptoms of leg pain induced by walking. The most powerful of these is painful and limited hip ROM which is pathognomonic for hip OA and rare in LSS. As such, hip ROM should be routinely assessed in all patients for which either diagnosis is considered. Numerous symptoms have some discriminating value, but many symptoms, such as back pain, pain climbing stairs and pain that is less while pushing a shopping cart, do not. Awareness that many symptoms have a modest prevalence in both diagnoses may reduce diagnostic error.

References

[1] Bohl WR, Steffee AD. Lumbar spinal stenosis. A cause of continued pain and disability in patients after total hip arthroplasty. Spine 1979;4:168–73.

[2] Offierski CM, MacNab I. Hip-spine syndrome. Spine 1983;8:316–21.

[3] Saito J, Ohtori S, Kishida S, et al. Difficulty of diagnosing the origin of lower leg pain in patients with both lumbar spinal stenosis and hip joint osteoarthritis. Spine 2012;37:2089–93.

[4] Swezey RL. Overdiagnosed sciatica and stenosis, underdiagnosed hip arthritis. Orthopedics 2003;26:173–4.

[5] McNamara MJ, Barrett KG, Christie MJ, Spengler DM. Lumbar spinal stenosis and lower extremity arthroplasty. J Arthroplasty 1999;8:273–7.

[6] Boden SD, Davis DO, Dina TS, Patronas NI, Wiesel SW. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects. J Bone Joint Surg Am 1990;72:403–8.

[7] Jacobsen S, Sonne-Holm S, Soballe K, Gebuhr P, Lund B. Radiographic case definitions and prevalence of osteoarthrosis of the hip: a survey of 4151 subjects in the Osteoarthritis Substudy of the Copenhagen City Heart Study. Acta Orthop Scand 2004;75:713–20.

[8] Kalichman L, Cole R, Kim DH, et al. Spinal stenosis prevalence and association with symptoms: the Framingham Study. Spine J 2009;9:545–50.

[9] Jordan JM, Helmick CG, Renner JB, et al. Prevalence of hip symptoms and radiographic and symptomatic hip osteoarthritis in African Americans and Caucasians: the Johnston County Osteoarthritis Project. J Rheumatol 2009;36:809–15.

[10] Ishimoto Y, Yoshimura N, Muraki S, et al. Associations between radiographic lumbar spinal stenosis and clinical symptoms in the general population: the Wakayama Spine Study. Osteoarthritis Cartilage 2013;21:783–8.

[11] Kim C, Nevitt MC, Niu J, et al. Association of hip pain with radiographic evidence of hip osteoarthritis: diagnostic test study. BMJ 2015;351:h5983.

[12] Moreland LW, Lopez-Mendez A, Alarcon GS. Spinal stenosis: a comprehensive review of the literature. Semin Arthritis Rheum 1989;19:127–49.

[13] Croft P, Cooper C, Wickham C, Coggon D. Defining osteoarthritis of the hip for epidemiologic studies. Am J Epidemiol 1990;132:514–22.

[14] Lee BH, Moon SH, Lee HM, Kim TH, Lee SJ. Prevalence of hip pathology in patients over age 50 with spinal conditions requiring surgery. Indian J Orthop 2012;46:291–6.

[15] Sembrano JN, Polly DW. How often is low back pain not coming from the back? Spine 2009;34:E27–32.

[16] Weinstein PR. Diagnosis and management of lumbar spinal stenosis. Clin Neurosurg 1983;30:677–97.

[17] Khan NQ, Woolson ST. Referral patterns of hip pain in patients undergoing total hip replacement. Orthopedics 1998;21:123–6.
[18] Altman RD. Criteria for the classification of osteoarthritis of the knee and hip. Scand J Rheumatol (Suppl) 1987;65:31–9.
[19] Wolfe F. Determinants of WOMAC function, pain and stiffness scores: evidence for the role of low back pain, symptom counts, fatigue and depression in osteoarthritis, rheumatoid arthritis and fibromyalgia. Rheumatology 1999;38:355–61.
[20] Yukawa Y, Kato F, Kajino G, Nakamura S, Nitta H. Groin pain associated with lower lumbar disc herniation. Spine 1997;22:1736–40.
[21] Khan AM, McLoughlin E, Giannakas K, et al. Hip osteoarthritis: where is the pain? Ann R Coll Surg Engl 2004;86:119–21.
[22] Lesher JM, Dreyfuss P, Hager N, Kaplan M, Furman M. Hip joint pain referral patterns: a descriptive study. Pain Med 2008;9:22–5.
[23] Rainville J, Lopez E. Comparison of radicular symptoms caused by lumbar disc herniation and lumbar spinal stenosis in the elderly. Spine 2013;38:1282–7.
[24] Katz JN, Dalgas M, Stucki G, et al. Degenerative lumbar spinal stenosis: diagnostic value of the history and physical examination. Arthritis Rheum 1995;38:1236–41.
[25] Devin CJ, McCullough KA, Morris BJ, Yates AJ, Kang JD. Hip-spine syndrome. J Am Acad Orthop Surg 2012;20:434–42.
[26] Tomkins-Lane C, Melloh M, Lurie J, et al. ISSLS prize winner: consensus on the clinical diagnosis of lumbar spinal stenosis: results of an International Delphi Study. Spine 2016;41:1239–46.
[27] Katz JN, Dalgas M, Stucki G, Lipson SJ. Diagnosis of lumbar spinal stenosis. Rheum Dis Clin North Am 1994;20:471–83.
[28] Iversen MD, Katz JN. Examination findings and self-reported walking capacity in patients with lumbar spinal stenosis. Phys Ther 2001;81:1296–306.
[29] Goh KJ, Khalifa W, Anslow P, Cadoux-Hudson T, Donaghy M. The clinical syndrome associated with lumbar spinal stenosis. Eur Neurol 2004;52:242–9.
[30] Lyle MA, Manes S, McGuinness M, Ziaei S, Iversen MD. Relationship of physical examination findings and self-reported symptom severity and physical function in patients with degenerative lumbar conditions. Phys Ther 2005;85:120–33.
[31] Cibere J, Thorne A, Bellany N, et al. Reliability of the hip examination in osteoarthritis: effect of standardization. Arthritis Rheum 2008;59:373–81.
[32] Martin HD, Kelly BT, Leunig M, et al. The pattern and technique in the clinical evaluation of the adult hip: the common physical examination tests of hip specialists. Arthroscopy 2010;26:161–72.
[33] Suri P, Rainville J, Kalishman L, Katz JN. Do older adults with lower extremity pain have the clinical syndrome of lumbar spinal stenosis. JAMA 2010;304:2628–36.
[34] Brown MD, Gomez-Marin O, Brookfield KF, Li PS. Differential diagnosis of hip disease versus spine disease. Clin Orthop Relat Res 2004;419:280–4.
[35] van Zyl AA. Misdiagnosis of hip pain could lead to unnecessary spinal surgery. SA Orthop J 2010;9:54–7.
[36] Walcott BP, Coumans JV, Kahle KT. Diagnostic pitfalls in spine surgery: masqueraders of surgical spine disease. Neurosurg Focus 2011;31:E1.
[37] Konstantinou K, Hider SL, Vogel S, Beardmore R, Somerville S. Development of an assessment schedule for patients with low back-associated leg pain in primary care: a Delphi consensus study. Eur Spine J 2012;21:1241–9.
[38] Kleiner JB, Thorne RP, Curd JG. The value of bupivacaine hip injection in the differentiation of coxarthrosis from lower extremity neuropathy. J Reumatol 1991;18:422–7.
[39] Deyo RA, Dworkin SF, Amtmann D, et al. Report of the NIH task force on research standards for chronic low back pain. Spine J 2014;14:1375–91.
[40] Cella D, Riley W, Stone A, et al. The Patient-Reported Outcome Measurement System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005-2008. J Clin Epidemiol 2010;63:1179–94.
[41] Terjesen T, Gunderson RB. Radiographic evidence of osteoarthritis of the hip: an inter-observer study of 61 hips treated for late-detected developmental hip dislocation. Acta Orthop 2012;83:185–9.
[42] Lurie JD, Tosteson AN, Tosteson TD, et al. Reliability of readings of magnetic resonance imaging features of lumbar spinal stenosis. Spine 2008;33:1605–10.
[43] Simel DL, Rennie D, Bossuyt PMM. The STARD statement for reporting diagnostic accuracy studies: application to the history and physical examination. J Gen Intern Med 2008;23:768–74.
[44] McGee S. Simplifying likelihood ratios. J Gen Intern Med 2002;17:647–50.
[45] Hulley SB, Cummings SR. Designing Clinical Research. Baltimore, MD: Williams & Wilkins; 1988.
[46] McLaughlin K, Heemskerk L, Herman R, Ainslie M, Rikers RM, Schmidt HG. Initial diagnostic hypotheses bias analytic information processing in non-visual domains. Med Educ 2008;42:496–502.
[47] Norman GR, Monteiro SD, Sherbino J, et al. The Causes of errors in clinical reasoning: cognitive biases, knowledge deficits, and dual process thinking. Acad Med 2017;92:23–30.