Research Report

Examination Findings and Self-Reported Walking Capacity in Patients With Lumbar Spinal Stenosis

Background and Purpose. Spinal stenosis is a common, often disabling, condition resulting from compression of the cauda equina and nerve roots. This study was designed to: (1) characterize the impairments of patients with lumbar spinal stenosis (LSS) and (2) to identify predictors of self-reported walking capacity. **Subjects.** Forty-three patients with symptomatic LSS, from 3 specialty clinics, were evaluated. Twenty-eight subjects (65%) were female. The subjects' median age was 73.6 years ($\overline{X}$=72.4, SD=10.3, range=45.7–90.7), and the median duration of low back pain was 24 months ($\overline{X}$=36.6, SD=41.6, range=0–216). **Methods.** Demographic data, medical history, and information about low back pain and symptoms (eg, numbness, tingling, and lower-extremity weakness) were collected using a standardized questionnaire and physical examination. **Results.** Twenty-two subjects (51%) had lower-extremity weakness, primarily of the extensor hallucis longus muscle. Thirty-five subjects (81%) had absent or decreased neurosensory responses (eg, pinprick, vibration, reflexes), and 28 subjects (66%) reported that they were unable to walk farther than 2 blocks. Women were more likely than men to report difficulties walking, as were subjects with abnormal Romberg test scores and those with greater pain during walking. **Discussion and Conclusion.** Pain and balance problems appeared to be the primary factors limiting ambulation in our subjects with LSS. [Iversen MD, Katz JN. Examination findings and self-reported walking capacity in patients with lumbar spinal stenosis. *Phys Ther.* 2001;81:1296–1306.]

Key Words: *Clinical signs and symptoms, Lumbar spinal stenosis.*

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Spinal stenosis is a common, often disabling condition[1] resulting from compression of the cauda equina and nerve roots. Spinal stenosis is generally classified as either primary, arising from congenital or developmental changes, or secondary, resulting from degenerative changes in the spinal canal.[2–4] Symptoms typically occur in the sixth to eighth decades of life.[5] Radiographic tests such as magnetic resonance imaging (MRI), computed tomography (CT), and myelography are often nonspecific,[6] and the correlation between the degree of stenosis observed by use of imaging studies and the severity of symptoms is poor.[7] As a result, clinicians often rely on patient history and physical examination findings to diagnose lumbar spinal stenosis (LSS).

Patients with LSS typically have chronic, episodic low back pain (LBP), which usually radiates to the lower extremities.[4] Symptoms of nerve root compression (eg, numbness, tingling) are common. These signs and symptoms are thought to result from vascular compromise to the vessels supplying the cauda equina or from pressure on the nerve root complex from facet joint osteophytes,[4,8,9] ligamentum flavum hypertrophy,[10–12] or bulging disk material.[13] Compression of the cauda equina produces the syndrome of neurogenic claudication,[14] which is characterized by bilateral lower-extremity pain during walking. Pain and sensory findings are often diffuse and may differ in severity, frequency, and rate of progression. Symptoms increase during walking and decrease when the person sits or flexes the trunk[4,15] because forward flexion increases the space for the cauda equina.

The sensitivity and specificity of using several examination findings and information from the patient history for distinguishing LSS from other back pain syndromes have been studied.[16] The researchers obtained detailed histories and conducted physical examinations as part of that study, and they were able to present only a fraction of the data in their report.[16] The focus of that study was on sensitivity and specificity of examination findings. The analysis was extensive and did not allow review of all aspects of the physical examination findings of the sample. Here we use the data gathered in that study to assess the accuracy of several widely held beliefs about

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LSS. These include beliefs that there is decreased lumbar lordosis, reduced lumbar range of motion, exacerbation of symptoms with extension and relief of symptoms with stooping, reduced ankle tendon reflexes, dermatomal hypoesthesia, lumbar paraspinal and gluteal spasm with associated trigger points, reduced straight leg raise, and vertebral joint dysfunction.[4,15–17]

The purposes of our study were to describe the complaints and physical examination findings of a sample of patients with LSS and to identify associations between aspects of the history and physical examination and self-reported walking capacity.

Method

Subjects

This descriptive study was part of a larger investigation assessing the diagnostic value (sensitivity and specificity) of the history and physical examination in patients with chronic LBP.[16] The study was approved by the institutional review board of the participating hospital. Patients were recruited from the practices of attending physicians at 3 specialty clinics: a center for spine disorders, an anesthesia-pain treatment unit, and an orthopedic spine practice. The participating physicians were 2 rheumatologists, an anesthesiologist, and 2 orthopedic surgeons. These physicians had practices with a major focus on LBP, and they had a range of 5 to 17 years of clinical experience (median=7 years, $\overline{X}$=9.4, SD=5.02). Patients were recruited if they were at least 40 years of age, had a history of LBP (radiating or nonradiating), had no cognitive impairments, were able to complete interviews in English, and provided informed consent.

Forty-three patients met the inclusion criteria. The subject characteristics are shown in Table 1. Twenty-eight subjects (65%) were female, and 41 subjects (95%) were Caucasian. Twenty-one subjects (48%) were recruited from the orthopedic practice, and the remaining 22 subjects (52%) were recruited from the pain center, spine center, and rheumatology practices. The median age of the subjects was 73.6 years ($\overline{X}$=72.4, SD=10.3, range=45.7–90.7). Twelve percent of the subjects had a history of diabetes, 5% previously had inner ear infections, and 5% had a history of alcohol use of more than one drink per day. The median duration of pain was 2 years ($\overline{X}$=36.6 months, SD=41.6, range=0–216). There was no statistically significant difference in duration of symptoms between men and women, as determined using a Wilcoxon test for nonparametric data. Seven subjects (16%) had previous low back surgery. Of these subjects, 2 had surgery for a herniated lumbar disk, 2 had laminectomies for LSS, and 3 had a spinal fusion.

Table 1.
Subject Characteristics (N=43)

Variable	N	%		
Female	28	65		
Center				
Orthopedic practice	21	48		
Spine center	11	26		
Rheumatology	9	21		
Pain center	2	5		
Percentage with previous back surgery	7	16		
Caucasian	41	95		
History of diabetes	5	12		
Disease of inner ear	2	5		
Drink >1 drink most days	2	5		
Variable	**$\overline{X}$**	**SD**	**Median**	**Range**
Age (y)	72.4	10.3	73.6	45.7–90.7
Duration of low back pain (mo)	36.6	41.6	24	0–216
Duration of leg pain (mo)	21.6	20.2	18	0–108

Results of CT scans, MRIs, radiographs, or a combination of these tests were available for 38 (88%) of the 43 subjects. According to the radiologist's report, these tests confirmed structural evidence of central or central-lateral spinal stenosis. Based on these results, the radiologist, using standardized criteria for classification (eg, millimeters of diameter of the spinal canal), classified 5 subjects (14%) as having mild stenosis, 16 subjects (43%) as having moderate stenosis, and 16 subjects (43%) as having severe stenosis. Consistent with the literature,[6] the correlation between severity of findings on radiographic reports and LSS symptoms (eg, pain, numbness, tingling, lower-extremity weakness), as measured by self-reported walking capacity, was poor (r_s=.2).

The diagnosis of LSS was made based on the expert opinion of the attending physicians. Expert opinion is a suitable, accepted approach to defining a syndrome where no gold standard exists. This approach has been used to assess classification criteria for rheumatoid arthritis and systemic lupus erythematosus.[18,19] Attending physicians interpreted salient aspects of the history, physical examination, and laboratory and radiologic evaluations. They also completed a visual analog scale in which they rated, from 0 to 100, their confidence that the patients' symptoms were due to compression of the nerve roots in the spinal canal from spinal stenosis. These physicians made this determination without knowing the researchers' evaluations. Only patients whose physicians were at least 80% confident of the diagnosis of LSS were included in our study.

Data Collection and Materials

Subjects were evaluated by 1 of 2 researchers who were not involved in their care and who did not know the physician's evaluation and diagnosis. The researchers were a rheumatologist with over 15 years of experience in the evaluation of spinal disorders and a medical student who was trained by the rheumatologist. The medical student completed a series of training sessions in an effort to ensure that her physical assessments would be similar to those of the rheumatologist. She conducted the examinations for the study after she met the criteria for proficiency by agreeing with the rheumatologist. However, reliability of raters was not measured. The researchers used physical examination procedures that were based on what we believe is standard practice.

Subjects completed a demographic questionnaire and provided information on comorbid conditions that we believed to be associated with balance and sensory changes, such as diabetes, inner ear infections, and alcohol use. The history and evaluation forms[16] contained questions on the location, duration, and frequency of pain; information on other low back symptoms such as balance problems, muscle weakness, numbness, and tingling; and questions regarding walking distance and difficulties ambulating. The questions about ambulation were a subset of a scale previously used to measure walking capacity in patients with LSS, a scale believed to produce reliable responses.[20] The internal consistency of measurements obtained with this LSS 5-item physical function scale in a previous study was .82.[21] Test-retest reliability was assessed on a subset of 23 patients with clinically confirmed LSS. The questionnaire was administered at baseline and again at 14 days. Using Spearman rank correlation coefficients, the test-retest reliability was .94.[21]

The physical examination conducted by the researcher included an assessment of posture, balance, lumbar range of motion, and muscle force; reflex and sensory testing; and palpation of soft tissues. In addition, medical records were reviewed to obtain information on radiographic findings of LSS and the use of epidural steroids.

Balance and Posture Evaluation

Balance was assessed using the Romberg test[22] and by visual inspection of stance during gait. The subjects performed the Romberg test by standing with their feet together and with their hands across their chest. The researcher assessed their ability to stand for a maximum of 10 seconds, first with eyes open and then with eyes closed, and ranked the subjects' response as "normal," "maintains balance through both conditions with compensatory movements," or "cannot finish test." The reliability and validity of Romberg test scores vary but improve considerably when standardized testing procedures are used.[23–26] Stance during gait was assessed by visual inspection and was documented as either wide-based, if the subjects' feet were positioned farther apart than their shoulders, or normal, if their feet were positioned at shoulder width. Posture was assessed in standing. Lumbar position was categorized, via visual inspection of the subjects in a standing position (lateral view), as "stooped forward," "no lordosis," "normal lordosis," or "excessive lordosis." To assess scoliosis, subjects were asked to bend forward slowly as the rater assessed the presence and direction of spinal curvature.[27]

Range of Motion, Pain Behavior, Muscle Force, and Sensation

Active lumbar extension and lateral flexion were assessed with the subjects in a standing position using a goniometer.[28] The Schober test[27] was used to measure the amount of flexion in the lumbar spine. A point was marked at the S2 level, and 2 more marks were made 5 cm below and 10 cm above S2. The distance between the top and bottom points was measured while the subject stood upright and then again as the subject flexed forward. The difference between these measurements indicated the amount of lumbar flexion.[27] Interrater reliability of measurements obtained with the Schober test is moderate (correlation coefficients of .59–.75) and varies for 10 people with LBP.[29,30] Pile et al[31] found an intraclass correlation coefficient of .75 for flexion in a sample of patients with ankylosing spondylitis. Pain during lumbar range of motion testing also was measured. For example, to assess the effect of lumbar extension on pain, subjects reported the extent and location of pain during 30 seconds of active lumbar extension in a standing position.

We used manual muscle testing (break tests) of the major muscle groups of the lower extremity to identify any myotomal patterns of weakness.[32] Manual muscle testing is frequently used to assess force, although the reliability and validity of the measurements have been questioned.[33–36] In a study assessing the results of manual muscle testing of lower-extremity muscles (ie, knee extensors, ankle dorsiflexors, great toe extensors) in 83 patients with low back pain, interrater reliability varied.[29] The patients were divided into 2 groups. Fifty patients were examined by 2 orthopedic surgeons, and 33 patients were examined by an orthopedic surgeon and a physical therapist. Kappa statistics were used to assess reliability between raters. Kappa values ranged from .10 to .85.[29] Frese and colleagues[37] found only a 50% to 60% agreement between raters for grading within one third of a grade for 4 muscle groups. The use of standardized testing procedures by trained personnel and documentation of presence or absence of weakness versus a 5-level grading scheme improved reliability slightly.[29,34,37,38] As

Deyo et al[1] contended, the presence or absence of ankle dorsiflexion weakness when compared with the contralateral muscle group seems to be a more precise assessment of muscle force, although they did not provide data to support this contention.

A straight-leg-raising test was used to assess the response to stretching on neural tissue.[39] A *positive straight leg raise* was defined as pain radiating below the knee at 70 degrees or less. The interrater reliability of measurements obtained with this test is moderate, with kappa values ranging from .56 to .66.[40,41] The sensitivity of the straight-leg-raising test in patients with LSS is about 50%.[1] Patellar tendon and Achilles tendon reflexes were evaluated and rated as "decreased," "normal," or "hypertonic."[27] The interrater reliability of measurements obtained with ankle reflex testing is low to moderate, with kappa values ranging from .39 to .50.[29,41] Sensory responses to pinprick were elicited in the dermatomal areas of the lower extremities.[27] Deyo et al[1] argued that patients distinguish differences in pain more accurately with pinprick testing and recommended testing the medial aspect, dorsum, and lateral aspect of the feet for more precise and efficient assessment, but again they supplied no data to support this recommendation.

Vibration was assessed at the medial head of the first metatarsal, medial tibia, and patella using a standard procedure. Two marks were placed on the distal end of each prong of a 128-Hz tuning fork at 0.5 and 5 cm. When the subject could not perceive the vibration or if vibration was perceived only when both marks were moving, this was considered abnormal.[16] The reproducibility of these neurosensory measures in the lower extremity among subjects with lumbar disk herniations is modest (kappa=.68).[29] Schwartz and Klima[42] stated that vibratory sensation using a 128-Hz tuning fork has moderate reliability, although no statistics were provided. Because we did not examine reliability for our sensory measures, we do not know how much error was associated with our measures.

Soft Tissue Assessment

Palpation was done over the spinous processes of L3 through L5 and lateral to these structures, and over the greater trochanter and piriformis muscle. If pain or tenderness was noted in any of these areas, a score of 1 was recorded on the evaluation form. If no pain or tenderness was noted, a score of 0 was assigned. This measurement has low reliability.[29]

Vascular Assessment

A primary characteristic of symptomatic LSS is claudication, a discomfort felt in one or both lower extremities that usually is described as dull, vague, and deep and that is brought on by walking. Claudication may be either vascular or neurogenic or both. Dorsalis pedis artery and tibialis posterior muscle pulses were palpated to evaluate the possibility of vascular claudication, which is brought on by ischemia. Pulses were rated as either "normal" or "diminished." Although we recognize that the sensitivity and specificity of this technique is modest,[43] it has been used traditionally to detect vascular insufficiency. The sensitivity of *neurogenic claudication*, defined as pain with ambulation or on standing in the presence of normal arterial pulses, is modest (0.60).[5]

Data Analysis

Analyses were performed using the SAS statistical package[44,*] on the subjects whose physicians were at least 80% confident that the symptoms were due to LSS. We used summary statistics to describe the characteristics of the sample and data elements of interest. Spearman correlation coefficients were used to test for associations among patient characteristics, physical examination findings, and self-reported walking capacity. In an effort to demonstrate convergent validity of data obtained with our self-reported walking capacity scale, we used Spearman rank correlation coefficients to determine the association between pain with walking uphill, pain with walking downhill, and pain on standing. Correlational tests were performed to address the specific hypothesis that pain with walking is the principal determinant of walking capacity. We believe that this procedure is necessary, as we did not have an acceptable measure of walking capacity and we therefore could not examine criterion validity. Wilcoxon rank sum tests were used to determine whether patient characteristics such as age, sex, or general health influenced self-reported walking capacity and to determine the relationship between self-reported walking capacity and problems ambulating. A multivariate logistic regression[45] identified correlates of self-reported walking capacity. The outcome, self-reported walking capacity, was dichotomized at the median and was regressed on patient characteristics and select physical examination findings hypothesized to influence self-reported walking capacity. The median value has no intrinsic meaning, but we believe that it provided an unbiased approach to dichotomizing function.

Results

Gait and Balance

People with LSS may exhibit "pseudocerebellar dysfunction,"[46] including a wide-based gait and poor balance. Seventeen subjects (43%) were observed to walk with a wide-based gait. Twenty-five subjects (61%) completed the Romberg test without compensatory movements, 13 (32%) finished the test using compensatory moments,

* SAS Institute Inc, PO Box 8000, Cary, NC 27511.

Table 2.
Balance and Gait Problems in Subjects With Lumbar Spinal Stenosis (N=43)

Physical Examination Findings	N	(%)
Wide-based stance	17	43
Romberg test results		
Normal	25	61
Compensatory	13	32
Cannot finish test	3	7
Cannot stand on heels	5	15
Cannot stand on toes	3	7
Self-report of walking problems		
Able to walk >2 blocks	15	34
Able to walk >15.2 m (50 ft) but <2 blocks	14	33
Able to walk <15.2 m (50 ft)	14	33
Severe/very severe difficulties with walking	27	63
Self-report of balance problems		
Balance problems in past month	13	32
Balance affected by prolonged walking or standing		
No	16	37
Yes, but no change	12	28
Yes, a little worse	4	9
Yes, much worse	10	23

Table 3.
Lumbar and Hip Range of Motion of Subjects With Lumbar Spinal Stenosis (N=43)

	N	(%)
Lumbar extension (active)		
<10°	28	65
>10°	15	35
Lumbar flexion (active)		
<30°	16	37
30°–45°	14	33
>45°	13	30
Schober test		
>2 cm	28	65
Hip (medial [internal] rotation)		
Right: <10° of motion	3	7
Left: <10° of motion	2	5

Table 4.
Tenderness With Palpation of the L3 to L5 Spinous Processes[a] and in the Region of the Piriformis Muscle and Greater Trochanter in Subjects with Lumbar Spinal Stenosis (N=43)

	Left of Structure		Spinous Process		Right of Structure	
Structure	N	%	N	%	N	%
L3	6	14	4	9	9	21
L4	6	14	7	16	10	23
L5	8	19	6	14	11	26
Piriformis muscle	6	14		5	12	
Greater trochanter	8	19			10	23

[a] For spinous processes, tenderness to the left and right refers to paraspinal tenderness.

and 3 (7%) could not complete the test. Thirteen subjects (32%) reported balance problems during the month preceding the evaluation, and 14 subjects (32%) believed that their balance worsened with prolonged walking (Tab. 2). There was little correlation between age and Romberg test scores (r_s=−.09, P=.54) or wide-based gait (r_s=.23, P=.14).

Posture and Range of Motion

People with LSS generally stoop forward to maintain comfort.[4] Seven subjects had a normal lordosis (16%), 7 (16%) stood with a stooped posture, and 28 (65%) had an essentially flat lumbar spine. Ten subjects (23%) were found on examination to have scoliosis. Lumbar extension was limited in 65% of the subjects. Sixteen subjects (37%) were limited in lumbar flexion (Tab. 3).

Palpation

Palpation of the spinous processes of L3 through L5 was done to determine the presence of muscle spasm and trigger points. In general, tenderness was more frequently reported lateral to the spinous process than over the spinous process. Eleven subjects (26%) demonstrated tenderness with palpation to the right of the L5 spinous process, and 8 subjects (19%) reported tenderness with palpation to the left of the L5 spinous process (Tab. 4).

Characteristics of Pain and Pain Behavior

Twenty-seven subjects (65%) reported having LBP at the time of the physical examination. Of these subjects, 33 (81%) had pain in the buttocks, 34 (84%) had pain in the thighs, 21 (51%) had pain in the calves, and 14 (35%) stated they had pain radiating to their feet. Seventeen subjects (39%) reported they had back pain all of the time. Based on a 5-point scale, ranging from no pain to very severe pain, 24 subjects (56%) stated they had either severe or very severe back pain, and 26 subjects (60%) reported having severe or very severe buttock, thigh, calf, or leg pain. Thirty subjects (72%) reported that their back pain intensified with prolonged walking (Tab. 5).

During the physical examination, 34 subjects (79%) complained of pain when they flexed their spine while standing. Pain during passive extension of the lumbar spine with the pelvis stabilized was measured at 5 seconds and then after 30 seconds. Twenty-nine subjects (67%) reported pain in their back after 5 seconds of extension. This number increased to 33 (77%) after 30 seconds. Lower-extremity pain also increased with prolonged lumbar extension (Tab. 6).

Table 5.
Self-Reported Discomfort in Buttocks, Thighs, Calves, and Feet With Physical Activities in Subjects With Lumbar Spinal Stenosis (N=43)

Self-Reported Pain Following Activities	Worse		No Change		Better	
	N	%	N	%	N	%
Walking uphill (n=37)	32	78	5	13	0	0
Walking	30	72	6	14	6	14
Standing 5 min	27	65	14	33	1	2
Walking downhill	20	48	13	31	2	5
Lying flat	20	48	9	21	13	31
Gettying up from chair	18	43	23	55	1	2
Seated	10	24	10	24	22	52
Bending forward	9	27	24	58	8	15
Side lying	5	12	8	20	28	68
Coughing	4	10	35	87	1	2

Table 6.
Pain During Range of Motion in Subjects With Lumbar Spinal Stenosis[a] (N=43)

Variable	N	%
Passive extension: pain after 5 s		
None	0	0
Back	29	67
Buttocks	7	16
Thighs	4	9
Calves	2	5
Feet	1	2
Passive extension: pain after 30 s		
None	0	0
Back	33	77
Buttocks	21	49
Thighs	22	51
Calves	12	28
Feet	7	16
Pain with active lumbar flexion in standing	34	79
Pain with lateral flexion either side	18	42

[a] Subjects may have answered more than one category.

Table 7.
Neurosensory Findings and Results of Lower-Extremity Manual Muscle Testing in Subjects With Lumbar Spinal Stenosis (N=43)

	Absent or Decreased		Normal	
	Number	(%)	Number	(%)
Pinprick				
Dorsal lateral foot	17	40	26	60
Dorsal medial foot	12	28	31	72
Lateral calf	9	21	34	79
Medial calf	9	21	34	79
Vibration				
First metatarsal head	35	81	8	19
Mid/medial tibia	23	54	20	46
Patella	16	38	26	62
Reflexes				
Ankle reflexes	39	91	4	9
Patellar relfexes	21	49	22	51
Manual muscle testing				
Extensor hallucis longus	18	42	34	79
Ankle plantar flexors	8	19	32	74
Ankle dorsiflexors	10	23	33	73
Knee extensors	11	26	35	81
Knee flexors	9	21	25	58

Self-Reported Neurosensory Problems and Sensory Evaluation Findings

Fifteen subjects (35%) reported severe or very severe numbness or tingling in their thighs, calves, or feet; 12 subjects (28%) reported mild to moderate discomfort; and 16 subjects (37%) were free of those symptoms. Of the subjects who had these symptoms, 21 (55%) reported having numbness or tingling in the lower extremities at least a few times per day. Thirteen subjects (32%) experienced a worsening of symptoms with prolonged standing or walking.

The majority of the subjects had abnormal responses to sensory testing in the lower extremities. Thirty-five subjects (81%) had absent or decreased responses to vibration, and 20 subjects (47%) had absent or decreased responses to pinprick. The dorsal medial foot and the dorsal lateral foot were the most common areas for diminished responses to pinprick. Thirty-nine subjects (91%) had abnormal responses to ankle reflex testing (Tab. 7). These impairments are consistent with L5-S1 nerve root involvement. All subjects could perform a straight leg raise in a supine position without discomfort. While sitting with the knee extended, 1 subject complained of discomfort.

Self-Reported Muscle Weakness and Manual Muscle Testing Results

Subjects were asked to report, via questionnaire, the severity and frequency of muscle weakness during the month before the study. Fourteen subjects (33%) reported severe lower-extremity weakness, 14 (33%) reported mild to moderate weakness, and 15 (35%) reported no lower-extremity weakness. Twenty-two subjects had symptoms of weakness at least a few times per day. Sixteen (63%) of the 26 subjects who reported muscle weakness with prolonged walking stated that their weakness increased with the duration of walking.

Twenty-two subjects (51%) demonstrated weakness in their lower extremities. The most frequent muscle groups involved were the extensor hallucis longus muscles (42%), the quadriceps femoris muscles (26%), and the ankle dorsiflexors (23%) (Tab. 7).

Peripheral Pulses

Thirty-seven subjects (88%) had absent or diminished peripheral pulses in their lower extremities. These

Table 8.
Components of the Self-Reported Walking Capacity Scale

In the Last Month, on a Typical Day:
How far have you been able to walk?
Over 3.2 km (2 miles)
Over 2 blocks, but less than 3.2 km (2 miles)
Over 15.2 m (50 ft), but less than 2 blocks
Less than 15.2 cm (50 ft)
Have you had difficulties walking?
None
Mild
Moderate
Severe
Very severe

abnormalities typically were bilateral and more marked in the tibialis posterior muscle pulses than in the dorsalis pedis artery pulses.

Self-Reported Walking Capacity

Twenty-eight subjects (66%) reported that they were unable to walk 2 or more blocks, and 27 subjects (63%) reported that they had severe or very severe difficulty walking. Measures of walking distance and difficulty walking were combined to create a measure of self-reported walking capacity (Tab. 8). First, walking distance was rescored from a 4-point scale to a 5-point scale. Next, the 2 variables were summed and averaged. The internal consistency of the scale in this cohort (Cronbach alpha) was .76. The median self-reported walking capacity score was 2.2 on a scale of 1 (worst) to 5 (best). To assess the validity of scores obtained with this scale, we calculated correlations between the self-reported walking capacity score and the responses to items on the questionnaire pertaining to pain with standing and walking uphill or downhill. Increasing leg pain with prolonged standing (r_s=−.60, P=.0001), walking uphill (r_s=−.46, P=.004), and walking downhill (r_s=−.51, P=.0016) were all moderately correlated with scores on the self-reported walking capacity scale.

Grades on the self-reported walking capacity scale were not normally distributed. Therefore, we chose to examine the strength of the relationships between subject demographics and physical examination findings and walking capacity using nonparametric tests of association. Subjects who had abnormal Romberg test scores and those with wide-based gait reported greater limitations in walking capacity (r_s=−.52, P=.008 and r_s=−.38, P=.02, respectively) than did subjects who had normal Romberg test scores or a normal-width base of support for gait. Women were more likely than men to report limitations with ambulation (median for women=1.67, median for men=3.3; P=.01). Age did not appear to be associated with limitations in self-reported walking capacity (r_s=−.06, P=.7).

We dichotomized self-reported walking capacity at the median value due to the nonparametric distribution of the measurements. Next, using multivariate logistic regression,[42] the dichotomized self-reported walking capacity was regressed on the following variables: age, sex, Romberg test score, self-reported ambulatory pain, and the number of discrete, weak lower-extremity muscles. The variables that correlated with self-reported walking capacity were sex, Romberg test score, and pain during walking. Women were more likely than men to report difficulties with walking (odds ratio [OR]=9.4, 95% confidence interval [CI]=7.4–66.7), as were subjects with abnormal Romberg test scores (OR=10, 95% CI=1.8–56.8) and those who reported severe or very severe pain during walking (OR=8.3, 95% CI=1.4–49.4). The model had a C statistic[43] value of .81, indicating that the model correctly assigned 81% of the subjects to the appropriate category of self-reported walking capacity.

Discussion and Conclusion

The primary purpose of this study was to describe the examination findings for patients with LSS in order to investigate whether commonly held beliefs about symptoms and signs associated with this condition seem to be warranted. The supposition that people with LSS have decreased lumbar lordosis[46] was affirmed. Thirty-five subjects (81%) had either a stooped posture or no lumbar lordosis. People with LSS are thought to experience pain with motion of the lumbar spine. We found that active lumbar extension was limited in two thirds of the subjects and that passive extension (in standing) most often resulted in back pain. In addition, the number of subjects who reported discomfort increased as the time spent in extension increased. These results support the hypothesis that narrowing of the spinal canal is increased with extension,[4,15] which leads to an increase in pain that, in turn, can restrict activity. However, 37% of these subjects were limited in lumbar flexion, and the majority (79%) reported pain with active flexion. Thus, it appears that lumbar motion can be restricted, perhaps due to prolonged pain and discomfort and perhaps also due to pain related to the intervertebral disk.

In our subjects, the most common activity associated with pain in the lower extremities was walking uphill. Although the posture assumed for this activity is generally one of flexion, this increase in pain with uphill walking may result from increased compressive forces on the spine.[11,12,45] We did not determine whether our subjects actually assumed a flexed posture when walking uphill. Fritz et al[47] recently described this phenomenon in a case study of a 2-stage treadmill test for individuals with pain due to LSS. Lying supine appeared to relieve pain in 13 subjects (31%) and appeared to be of no benefit or to increase pain in the remaining subjects. None of the subjects had a positive straight leg raise on examination, although we believe that many clinicians would not expect a positive test, except perhaps in cases of foraminal stenosis.

Weakness of the extensor hallucis longus muscle and decreased sensation to pinprick on the lateral calf and the medial aspect of the dorsum of the foot were prevalent in our subjects, reflecting L5 nerve root dysfunction. Approximately half the subjects had a decrease in lower-extremity manual muscle test grades that indicated weakness and that may be attributed to self-imposed restrictions on functional activities as a result of activity-induced discomfort. Changes in sensation varied in severity but appeared to follow a dermatomal pattern.

Balance disturbances, difficulties walking, and limitations in walking distance also were common complaints. Balance disturbances, as measured by the Romberg test, were not associated with age. One possible explanation for the lack of correlation between age and balance problems may be the lack of variability of age in our sample. However, we believe this is not a likely explanation because the ages of the subjects in our cohort ranged from 46 to 91 years, with a median age of 73.6 years ($\overline{X}=72.4$, SD=10.3). Our results suggest that balance disturbances are a primary factor that limit walking. Few data exist describing the accuracy of physical examination findings in people with LSS.[1,16] More research is needed to determine the diagnostic criteria for and natural history of LSS.

Our second objective was to identify variables that correlate with self-reported walking capacity. Women were more likely than men to report limitations in walking capacity. This was an unexpected finding. Previous studies of gender differences in the use of elective surgery for total joint replacements (hip and knees) and laminectomy for LSS demonstrated that women were more likely than men to delay surgery and, therefore, to have worse functional status at the time of surgery and more symptoms (eg, pain, decreased range of motion, weakness).[48,49] We found, however, no difference in the self-reported duration of symptoms between men and women. This difference in walking capacity was an interesting finding that warrants further research.

Subjects who reported having pain when they walked and those with balance problems were also more likely to report limitations in walking capacity. Our results suggest that difficulty walking is a primary complaint of people with LSS that results from pain and balance disturbance. These results are consistent with what other researchers[17,48] have observed. Unfortunately, we were unable to fully assess the impact of comorbidites in this study.

Several limitations of our study should be acknowledged. Readers should note that we did not formally assess the reliability of the data obtained with the physical examination measures in this study due to limitations in funding. We present the readers with information generally known about the reliability of data obtained with the physical examination procedures in patients with LBP. These examination procedures are commonly used in clinical settings but vary in their reliability and validity. Reduced reliability, in our opinion, may have led to a bias, diluting the impact of the physical examination findings on self-reported walking capacity. This may help, in our view, to explain why certain physical examination findings, such as reduced muscle force, were not predictors of walking capacity. Our subjects may have had more severe functional limitations than patients typically seen in a community setting, because they were seeking care in a tertiary care institution. However, because this was a cohort of patients who were not getting surgery, they are likely typical of patients who may be referred for physical therapy. Moderate to strong correlations existed between the responses on the self-reported walking capacity scale and the responses to questions regarding leg pain during walking, supporting the validity of data obtained with the scale.

We believe that our study has several strengths. Physical examinations were conducted by trained clinicians on subjects with LSS confirmed by physicians using what we considered stringent criteria. We contend that the potential for interviewer bias was reduced through the use of standardized data collection procedures and forms. The researchers who conducted the physical examinations did not know the patients' diagnosis.

Lumbar spinal stenosis is a chronic progressive condition that can lead to restrictions in ambulation and eventually limit patients' ability to perform activities of daily living.[50] Few data exist describing the broad picture of this condition using a sample of patients with LSS. Our data suggest that neurosensory changes, predominately at the L5-S1 level, are common and that patients experience difficulties with walking secondary to pain and balance disturbances. Women are more likely than men to report problems with walking. The reason for this difference in reporting is unclear. More research is needed to describe the accuracy of physical examination procedures in this cohort of patients.

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