Pain Physician 2013; 16:E715-E723 • ISSN 2150-1149

Observational Report

Gender Difference of Symptom Severity in Lumbar Spinal Stenosis: Role of Pain Sensitivity

Ho-Joong Kim, MD[1], Bo-Gun Suh, MD[1], Dong-Bong Lee, MD[1], Jae-Young Park, MD[1], Kyoung-Tak Kang, MS[2], Bong-Soon Chang, MD[3], Choon-Ki Lee, MD[3], and Jin S. Yeom, MD[1]

From: [1]Spine Center and Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital, Sungnam, Korea; [2]Department of Mechanical Engineering, Yonsei University, Seoul, Korea; [3]Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Hospital, Seoul, Korea

Address Correspondence:
Jin S. Yeom, MD
Spine Center
Dept. of Orthopaedic Surgery
Seoul National University College of Medicine
Seoul National University Bundang Hospital
166 Gumiro, Bundang-gu, Sungnam, 463-707, Republic of Korea
E-mail: highcervical@gmail.com

Disclaimer: This study was partially supported by Dae-Woong Pham Co.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might post a conflict of interest in connection with the submitted manuscript.

Manuscript received: 04-09-2013
Revised manuscript received: 05-31-2013
Accepted for publication: 06-04-2013

Free full manuscript: www.painphysicianjournal.com

Background: Given that there are gender differences in pain perception, it is likely that there are differences in pain responses between men and women with lumbar spinal stenosis (LSS). Furthermore, these differences may lead to different degrees of impairment in both daily activities and quality of life between men and women.

Objective: To elucidate the difference of LSS symptom severity between genders in relation to pain sensitivity.

Study Design: Retrospective analysis of prospectively collected data.

Methods: A total of 160 patients who had symptomatic degenerative lumbar spinal stenosis completed a series of questionnaires on their first visit in the outpatient clinic, including a pain sensitivity questionnaire (PSQ) (total PSQ and PSQ-minor), Oswestry Disability Index (ODI), visual analog scale (VAS) for back pain, and Short Form-36 (SF-36). Using magnetic resonance images, the degree of canal stenosis and disc degeneration were graded based on the method by Schizas and the Pfirrmann classification, respectively. Symptom severity, pain sensitivity, and radiologic findings were compared between men and women. In each gender group analysis, the correlation between pain sensitivity and symptom severity was analyzed.

Results: After adjustment for age and the grade of disc degeneration, the pain sensitivity represented by total PSQ and PSQ-minor was significantly higher in women than in men. Moreover, there was a higher VAS for back pain/leg pain and ODI in women compared to men after adjustment for body mass index (BMI), age, and the grades of canal stenosis and disc degeneration. After additional adjustment for pain sensitivity including total PSQ and PSQ-minor, there was no difference in VAS for back pain/leg pain between genders. On the SF-36 women demonstrated a lower quality of life than men in terms of Physical Function, Role Physical, Bodily Pain, General Health, and Physical Component Summary. Each gender group analysis showed that pain sensitivity was associated with symptom severity and disability caused by LSS in both women and men.

Limitations: The present study did not evaluate psychological factors including catastrophizing and/or undiagnosed personal traits which possibly can influence the severity of symptoms from LSS.

Conclusions: Women showed increased low back pain and leg pain due to degenerative LSS compared to men. The current study demonstrates that this difference in symptom severity may be partly mediated by pain sensitivity.

Key words: Lumbar spinal stenosis, gender difference, visual analog scale, Oswestry Disability Index, Short Form-36, pain sensitivity

Pain Physician 2013; 16:E715-E723

Recent research has shown there are gender differences in pain perception (1-4). Women are at a higher risk than men for developing chronic pain disorders, including temporomandibular disorders, fibromyalgia, migraine and chronic tension type headache, and irritable bowel syndrome (5), in which women report more widespread pain and more severe affective symptoms (6-8). Experimental studies consistently demonstrate gender-based differences in pain sensitivity (9,10), with women demonstrating lower pain thresholds and tolerances for a variety of stimuli. Furthermore, epidemiologic and research surveys have demonstrated that pain-related symptoms occur more frequently among women than men in the general population (11,12).

Lumbar spinal stenosis (LSS) is a degenerative arthritic disease of the spine and a common condition in the elderly population. It causes in decreased function and increased physical impairment and can also cause impaired strength and balance as well as walking intolerance with increased levels of pain (13, 14). Previous studies have shown mixed results pertaining to gender-based differences in the prevalence of LSS due to differences in methodology (15,16). A recent study using physical performance measures with a population-based cohort has clarified the prevalence of symptomatic LSS between men and women in the general population (4); there was no significant difference between genders, even though there was a difference in the prevalence of symptomatic LSS distribution by age strata between men and women (4). Nonetheless, little is known about the gender-based differences in symptom severity in LSS.

Considering gender differences in pain perception, there are likely differences in pain responses between men and women with LSS. Furthermore, these are likely associated with differences in the degree of impairment with respect to both physical function and quality of life between men and women. Therefore, we hypothesized that women with LSS might have accentuated pain responses and greater related disability than men with LSS. The purpose of this study was to find out if there is a gender difference in LSS symptom severity in relation to pain sensitivity.

Methods

Study Design

The study was approved by the hospital institutional review board. All of the prospective data included in this study were obtained from medical records collected as part of the routine care of patients. The data were reviewed retrospectively with personal information redacted. This study included 160 patients with back pain and/or leg pain caused by degenerated LSS who had visited the outpatient facilities of the spine center in the department of orthopedic surgery from March 2012 through October 2012. The inclusion criteria were patient age from 50 to 80 years without any acute disease and outpatient visits for walking intolerance due to neurogenic claudication caused by degenerative central spinal stenosis without any other musculoskeletal complaints. When a patient's walking distance in a single trial was less than 500 meters, we considered that patient to have walking intolerance. The diagnosis for LSS symptoms required 1 or more of the following symptoms with radiological stenotic lesion in the lumbar spine, which are pain, numbness and neurological deficits in the lower extremities and buttocks, and bladder/bowel dysfunction. The symptom characteristics should have been induced or exacerbated with walking or prolonged standing and relieved with lumbar flexion, sitting, or recumbent position. Patients were excluded if they had only foraminal stenosis without central stenosis, if they had pain or disability at other joints, if their symptom duration was less than 3 months, if they had a history of a psychological disorder or peripheral vascular disease, or if there was any concurrent serious medical condition affecting disability and general health status, including sepsis or cancer. Of the 160 patients there were 51 women and 109 were men.

Outcomes Assessment

Prospectively planned evaluations included a detailed medical history, a physical examination, and completion of a series of questionnaires, including walking distance in a single trial without rest, pain sensitivity questionnaire PSQ, Oswestry Disability Index (ODI), visual analog scale (VAS) for back pain, and Short Form-36 (SF-36). All data were recorded at the first patient visit.

The ODI is a self-administered questionnaire measuring "back-specific function" on a 10-item scale with 6 response categories each. Each item is scored from 0 to 5 and the summation of each item is transformed to a 0–100 scale (17,18). The VAS for back pain/leg pain was assessed using a bar with "none" on one end (zero) of a 100-mm line and "disabling pain" on the other end (100). Especially, VAS for leg pain at the onset of claudication during walking was asked of patients with

LSS. The patient placed a mark on the 100-mm line for VAS for back pain/leg pain, and the distance (mm) at the mark from the zero point was considered to be the score. General health status was assessed with the Short Form-36 (SF-36). The raw scores for the 8 subscales and the 2 summaries of the SF-36 (Physical Function, Role Physical, Bodily Pain, General Health, Vitality, Social Function, Role Emotion, and Mental Health / Physical Component Summary and Mental Component Summary) were transformed into norm-based scoring (19).

Pain Sensitivity Questionnaire

The PSQ has previously been introduced (20,21). It is composed of 17 items, each describing a daily life situation. The patient is asked to rate how painful a situation would be on a numeric rating scale ranging from 0 (not painful at all) to 10 (worst pain imaginable) (Table 1) (20, 21). Patients were carefully instructed to rate their own pain intensity, not pain aversiveness or the fear associated with the situation described by a clinical researcher. Fourteen of a total of 17 items are related to simulated situations that are rated as painful by the majority of healthy patients. The painful items covered a range of pain intensities, a variety of different types of pain such as hot, cold, sharp, and blunt pain and body sites including the head, and upper and lower extremities. However, 3 other items described situations that are normally not rated as painful by healthy patients. These items were not included in the final score. Completion of the PSQ usually took 15 minutes with the assistance of a clinical researcher.

In a previous study (20), factor analysis identified 2 subscores of the PSQ, consisting of the PSQ-moderate score and the PSQ-minor score, each including 7 items that on average were rated as moderately painful (mean rating 4–6 on the 11-point scale, PSQ-moderate) or as causing minor pain (mean rating < 4, PSQ-minor). In the present study, PSQ-minor and the total PSQ score are presented because they are more correlated with experimental pain sensitivity than is the PSQ-moderate score (20,21).

Radiological Analysis

Radiologic analysis was performed using magnetic resonance imaging findings. First, the grading of canal stenosis was based on the cerebrospinal fluid (CSF)/ rootlet ratio as seen on axial T2 images according to the method by Schizas et al (22). If the patient had canal stenosis at multiple levels, the most stenotic level was taken into account for grading. The grading description is as follows: Grade A stenosis indicates that there is clearly visible CSF inside the dural sac, but its distribution is inhomogeneous; A1 indicates that the rootlets lie dorsally and occupy less than half of the dural sac area; A2 indicates that the rootlets lie dorsally in contact with the dura but in a horseshoe configuration; A3 indicates that

Table 1. *Pain sensitivity questionnaire.*

Pain sensitivity questionnaire	
Pain sensitivity-minor	
3.	Imagine your muscles are slightly sore as the result of physical activity.
6.	Imagine you have mild sunburn on your shoulders.
7.	Imagine you grazed your knee falling off your bicycle.
10.	Imagine you have a minor cut on your finger and inadvertently get lemon juice in the wound.
11.	Imagine you prick your fingertip on the thorn of a rose.
12.	Imagine you stick your bare hands in the snow for a couple of minutes or bring your hands in contact with snow for some time, for example, while making snowballs.
14.	Imagine you shake hands with someone who has a very strong grip.
Pain sensitivity-moderate	
1.	Imagine you bump your shin badly on a hard edge, for example, on the edge of a glass coffee table.
2.	Imagine you burn your tongue on a very hot drink.
4.	Imagine you trap your finger in a drawer.
8.	Imagine you accidentally bite your tongue or cheek badly while eating.
15.	Imagine you pick up a hot pot by inadvertently grabbing its equally hot handles.
16.	Imagine you are wearing sandals and someone with heavy boots steps on your foot.
17.	Imagine you bump your elbow on the edge of a table ("funny bone").

the rootlets lie dorsally and occupy more than half of the dural sac area; A4 indicates that the rootlets lie centrally and occupy the majority of the dural sac area; Grade B stenosis indicates that the rootlets occupy the whole of the dural sac, but they can still be individualized. Some CSF is still present giving a grainy appearance to the sac; Grade C stenosis indicates that no rootlets can be recognized and the dural sac demonstrates a homogeneous gray signal with no CSF signal visible. There is epidural fat present posteriorly; Grade D stenosis indicates there is no epidural fat posteriorly in addition to no rootlets being recognizable (22).

The degree of disc degeneration was graded from T2-weighted images with the Pfirrmann classification (23). The patient's disc degeneration grade was decided by taking into account the most degenerated disc. Grade I indicates a normally shaped disc without horizontal bands and a clear distinction between the nucleus and annulus. Grade II indicates an inhomogeneously shaped disc with horizontal bands and some blurring between the nucleus and annulus. Grade III indicates an inhomogeneously shaped disc with slightly decreased height and blurring between the nucleus and annulus, but still a recognizable annulus shape. Grade IV indicates an inhomogeneously shaped disc with moderately decreased height and hypointense signal and no distinction between the nucleus and annulus. Grade V indicates the same as grade IV, but the disc space is collapsed.

Statistical Analysis

An independent t test was used for comparison of demographic data (age, BMI), variables of symptom severity (duration, VAS, ODI, SF-36), and PSQ scores between men and women. For adjustment of confounding biases such as grades of radiologic severity (canal stenosis and disc degeneration), and age, we used analysis of covariance. The difference in the grades of canal stenosis and disc degeneration between men and women was analyzed using the Chi-square test. For each gender group analysis, a Pearson correlation was used for comparison of variables between total PSQ/PSQ-minor and the symptomatic severity such as VAS for leg pain/back pain and ODI. In order to control confounding biases, including grades of canal stenosis, disc degeneration, and age, the partial correlation test was also used. Intraclass correlation coefficients (ICC model 3, 1) were used to describe the test-retest reliability of total PSQ scores. Sixty patients completed the second assessment over an interval of 4 weeks. Repeated measurements of total PSQ scores showed high ICC (from 0.82 to 0.93). All statistical analyses were performed with the SPSS 16.0.0 statistics package (SPSS, Inc., Chicago, IL). A P value < 0.05 was considered significant.

Results

Comparison of Baseline Data and Pain Sensitivity between Men and Women

There was no difference in BMI or distribution of canal stenosis grade between genders. However, the average age in men was significantly lower than that of women (P = 0.011), and the grade of disc degeneration was differently distributed between men and women (P < 0.001). There was also no significant difference in the mean walking distance in a single trial walk between men and women (Table 2). Total PSQ and PSQ-minor scores were significantly different between genders. Women had higher total PSQ and PSQ-minor scores than men (P = 0.002, 0.003, respectively). Even after adjustment for age and the grade of disc degeneration, the pain sensitivity represented by total PSQ and PSQ-minor scores was significantly higher in women than in men (total PSQ; P = 0.004, PSQ-minor; P = 0.008) (Table 2).

Gender-based Differences in Symptom Severity for Patients with LSS

The mean VAS for back pain was 65.12 ± 23.03 for women and 54.05 ± 26.94 for men (P = 0.011); the mean VAS for leg pain was 76.84 23.03, 76.84 ± 19.56,64.28 ± 20.54 for men (P = 0.001); and the mean ODI score was 47.54 ± 17.20 for women and 37.16 ± 14.47 for men (P < 0.001).

Even after adjustment for BMI, age, and the grades of canal stenosis and disc degeneration, the scores for VAS for back pain/leg pain and ODI were higher in women than in men (Table 2). Furthermore, following an additional adjustment for pain sensitivity including total PSQ and PSQ-minor, there were no differences in VAS for back pain or leg pain between genders (both; P = 0.152). However, ODI was significantly different between men and women, even after the additional adjustment for pain sensitivity (P = 0.005).

Gender Difference in Health-related Quality of Life

For health-related quality of life represented by an SF-36 score, differences between the genders were seen in terms of Physical Function, Role Physical, Bodily Pain, General Health, and Physical Component Summary

Table 2. *Comparison of baseline data, pain sensitivity, and symptom severity in the patients.*

	Men	Women	*P*
N	51	109	
Age (years)	60.96 (12.72)	66.33 (9.36)	0.011
BMI (kg/cm2)	25.95 (3.61)	25.79 (2.78)	0.857
Symptom duration (months)	13.5 (5.23)	11.1 (6.52)	0.134
Walking distance in a single trial without rest (meter)	213 (89.32)	232 (95.21)	0.158
The grade of spinal stenosis (A : B : C : D) (%) by Schizas (22)	25.5 : 12.8 : 40.4 : 21.3	22.5 : 9.2 : 36.7 : 31.6	0.311
The grade of disc degeneration (III : IV : V) (%) by Pfirrmann (23)	25.5 : 48.6 : 27.7	10.3 : 30.9 : 58.8	< 0.001
Total PSQ	11.27 (3.85)	13.38 (2.90)	0.002 (0.004)*
PSQ-minor	4.95 (2.07)	5.94 (1.67)	0.003 (0.008)*
VAS for back pain	5.40 (2.69)	6.51 (2.30)	0.011 (0.012)*
VAS for leg pain	6.42 (2.05)	7.68 (1.95)	0.001 (0.006)*
ODI	37.16 (14.47)	47.54 (17.20)	< 0.001 (< 0.001)*

Values are mean values (SD). BMI = body mass index, SD= standard deviation, PSQ = pain sensitivity questionnaire, VAS = visual analog pain scale, ODI = Oswestry Disability Index, **P* value adjusted for age, BMI, and the grade of disc degeneration/canal stenosis with ANCOVA (Analysis of covariance).

Table 3. *Comparison of health related quality of life (SF-36) in patients with LSS between genders*

SF-36 scales and summaries	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
Men	31.93	33.98	31.31	41.37	45.58	35.61	38.23	40.11	33.28	43.64
Women	27.46	29.38	29.03	36.76	38.92	32.66	31.59	36.73	29.34	38.14
P value	0.018	0.022	0.012	0.016	0.192	0.086	0.138	0.797	< 0.001	0.233

Values are mean values. PSQ = pain sensitivity questionnaire, R = correlation coefficient, *P* value adjusted for BMI and age with ANCOVA (Analysis of covariance).

after adjustment for age and BMI. The mean Physical Function was 27.46 ± 10.23 for women and 31.93 ± 9.13 for men ($P = 0.018$). The mean Role Physical was 29.38 ± 8.96 for women and 33.98 ± 9.40 for men ($P = 0.022$). The mean Bodily Pain was 29.03 ± 7.33 for women and 31.31 ± 7.15 for men ($P = 0.012$). The mean General Health was 36.76 ± 10.55 for women and 41.37 ± 9.22 for men ($P = 0.016$). The mean Physical Component Summary for women was 29.34 ± 7.68 and 33.28 ± 8.07 for men ($P < 0.001$) (Table 3). Thus, significantly lower values for women were seen on 4 scales and one summary score. Women also demonstrated a lower quality of life than men in all subscales and summaries, even though the differences were not statistically significant in the other domains and scale (Fig. 1).

Gender Group Analysis for Pain Sensitivity

Each gender group analysis showed that pain sensitivity was significantly associated with symptom severity and disability caused by LSS in both men and women. Adjustment for age and the grade of canal stenosis/disc degeneration yielded a higher correlation and more statistical significance between total PSQ/PSQ-minor and VAS for back/leg pain and ODI (Table 4). Correlation coefficients were not vastly different between genders.

Discussion

In general, women patients more often present with low back and radiating leg pain and more frequently undergo spine surgery than men patients (24). The number of hospital patient discharges due to low back pain was 805,000 for men and 1,091,000 for women in the US in 2007. Among them, lumbar fusion surgery was performed in 79,000 men and 101,000 women (24). Furthermore, low back pain is found more frequently among women than men, with women representing 56% of the health care visits in the US in 2006 (24). Women also reported higher levels of back pain and slightly more bed days than did men (24). Other previous studies have reported that the prevalence of musculoskeletal pain and low back pain is higher in women than in men (25,26). This gender difference in pain perception has been explained by several plausible

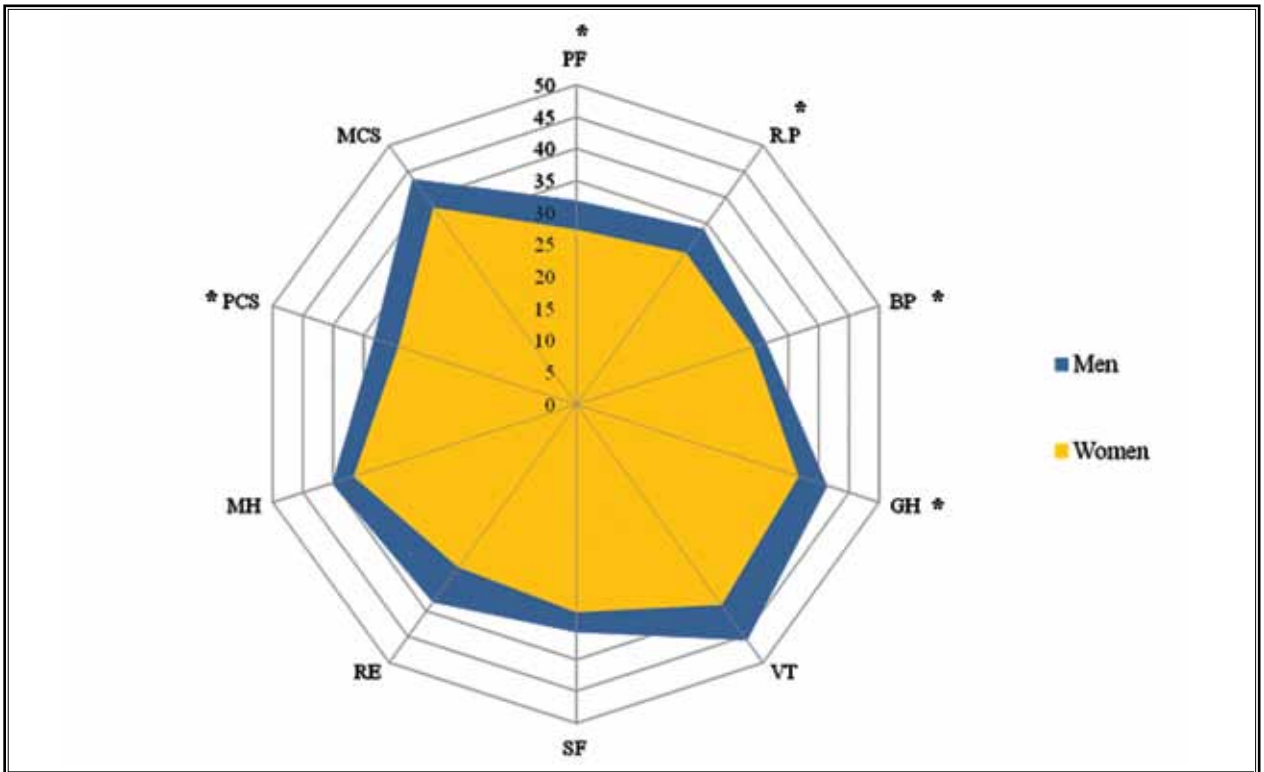

Fig. 1. *Comparison of health-related quality of life measured by SF-36 between genders (*; P < 0.05 between men and women, PF, physical functioning; RP, role physical; BP, bodily pain; GH, general health; VT, vitality; SF, social function; RE, role emotion; MH, mental Health; PCS, physical component summary; MCS, mental component summary).*

Table 4. Subgroup analysis for correlations between pain sensitivity and VAS for back/leg pain and ODI.

			VAS for back	VAS for leg	ODI
Men	PSQ-minor	R	0.408 (0.565)	0.314 (0.371)	0.197 (0.411)
		P value	0.007 (< 0.001)	0.046 (0.031)	0.212 (0.016)
	Total PSQ	R	0.411 (0.548)	0.310 (0.351)	0.230 (0.427)
		P value	0.007 (0.001)	0.049 (0.042)	0.142 (0.012)
Women	PSQ-minor	R	0.326 (0.418)	0.317 (0.372)	0.312 (0.399)
		P value	0.003 (< 0.001)	0.004 (0.001)	0.004 (0.001)
	Total PSQ	R	0.328 (0.407)	0.357 (0.390)	0.328 (0.389)
		P value	0.002 (< 0.001)	0.001 (0.001)	0.002 (0.001)

PSQ = Pain sensitivity questionnaire, VAS = visual analog pain scale, ODI = Oswestry Disability Index, R = correlation coefficient, Parenthesis means the value adjusted for age and the grade of canal stenosis/disc degeneration with partial correlation test.

mechanisms (1-3,5). Recent research has also emphasized that pain sensitivity is a determinant of symptom severity or increased pain perception (27-29). Therefore, in the present study, we intended to demonstrate the role of pain sensitivity in gender-based differences in symptom severity in LSS.

The validity and reliability of the assessment tools for pain sensitivity are prerequisites for drawing conclusions from the results of the current study. For a quantitative assessment of pain sensitivity, we used the validated PSQ instead of the experimental pain sensitivity test, which was recently developed by Ruscheweyh et al (20,21). In both healthy participants and chronic pain patients, the validated PSQ can predict the results of experimentally obtained pain intensity ratings, and in principle, it should be appropriate and valid for assess-

ment of pain perception. Furthermore, high intrarater reliability (ICC from 0.82 to 0.93) was also demonstrated in the present study. Therefore, the present study could validly assess pain sensitivity in patients with LSS.

In this study, because the mean age of women was much greater than that of men, all statistical analyses were performed after adjusting for age. Consistent with a previous study (30), the current study also showed women with LSS had a higher VAS for back pain /leg pain and ODI than men with LSS after adjustment for BMI, age, and the grade of canal stenosis/ disc degeneration. This finding indicates that women suffer more from LSS compared to men, despite similar grades of canal stenosis and disc degeneration. This might explain why women undergo spine surgery more frequently than men, despite the similar prevalence of LSS between men and women (4,24). A previous study also reported that preoperative low back and low extremity pain was greater in women than in men, and women tend to have less satisfactory results after surgery than men (30,31). With respect to the increased levels of back and leg pain in women, previous studies have suggested possible mechanisms for the variation in pain perception between genders, which have been portrayed as either biological, such as hormonal differences, or psychological, including depression, pain summation, and catastrophizing (3,30-32).

Among these possible mechanisms for gender differences in pain from LSS, we focused on pain sensitivity. In the present study, women demonstrated higher total PSQ and PSQ-minor scores than men after adjustments for BMI, age, and radiologic severities. Interestingly, after adjustment for pain sensitivity in general linear models including pain sensitivity, there was no longer a significantly higher level of VAS for back/leg pain in women compared to men. This finding corroborates the role of pain sensitivity in increased pain perception in women with LSS (30). However, even after adjustment for pain sensitivity and covariates, ODI was still significantly higher in women. This implies that ODI is determined by a more complex mechanism. Disability comprises 3 components: impairments, activity limitations, and participation restrictions (33). The ODI proved to capture not only the "pain intensity" component in LSS, but also a wide range of impairments of daily activities (33). Higher pain intensity does not always mean a higher functional impairment. Therefore, the impact of LSS on individual disability cannot be explained only by pain severity related to pain sensitivity. On the other hand, each gender group analysis showed that total PSQ/PSQ-minor score was correlated with VAS for leg pain/back pain in both men and women. These findings suggest that pain sensitivity has a significant correlation with the symptom severity of LSS, not only in women, but also in men.

After adjusting for age and BMI, there was still a gender difference in health-related quality of life, as measured by SF-36, in patients with LSS; men scored significantly higher on the SF-36 than women in Physical Function, Role Physical, Bodily Pain, General Health, and Physical Component Summary. However, it should be interpreted cautiously because a higher SF-36 score in men has been noted in several other studies and even in the general population (19,34,35). Nevertheless, several possible explanations can be offered to account for the relatively lower scores on SF-36 scales in women with LSS. Health-related quality of life measured by SF-36 reflects the functional ability and subjective feeling of an individual and is a biomedical and social–psychological concept (36). Therefore, increased pain perception for back/leg pain in women due to higher pain sensitivity would be negatively correlated with scores on SF-36 scales. Previous studies have consistently reported that chronic pain has a negative impact on quality of life (37-39). Women are likely to be more disabled by increased low back/leg pain caused by LSS. Second, increased catastrophizing of pain in women with LSS likely plays a significant role in lowering quality of life. Pain catastrophizing is an exaggerated negative orientation to anticipated or actual pain and has been associated with important pain-related outcomes, including greater pain intensity, pain chronicity, and anxiety, which is correlated with pain sensitivity (20,40). In a previous study, pain catastrophizing showed the strongest association with quality of life and had a stronger effect than pain intensity (39). Therefore, we can assume that significantly higher levels of back pain/ leg pain in women might be associated with impaired health-related quality of life.

There are several shortcomings in the current study. First, the clinical symptoms in degenerative spinal disease are dynamic in nature. That is, the pain that patients perceive is not constant, but changes in response to treatment or spontaneously without any treatment. Therefore, symptom severity might be dependent on when the assessment is done. In order to eliminate this bias, the inclusion criteria were confined only to degenerative lumbar stenosis that tends to cause chronic pain, rather than acute pain as with a herniated nucleus pulposus. Furthermore,

the questionnaires from patients were collected at the first visit in the outpatient clinic; symptoms at the first visit had not changed in the previous 2 months. Second, for the assessment of radiological severity, the multiple lesions of canal stenosis and/or disc degeneration and the grade of facet degeneration were not considered as variables because limited numbers of patients in the present study restricted inclusion of this variable. Third, different numbers of men and women patients were included and the mean age was significantly different between them. However, the definite differences in variables for pain and disability between genders after adjustment for age imply that this was not likely to influence the current results. Fourth, the present work could have evaluated psychological factors including catastrophizing and/or undiagnosed personal traits which can influence the severity of LSS symptoms (6,36). However, a previous study has reported that PSQ is significantly correlated with the pain catastrophizing scale (20). In addition, patients with a history of psychological disorder such as depression, psychosis, and somatization disorder were excluded in the current study. Furthermore, it should be considered that the country where the study was conducted has no racial diversity. Previous literature has reported that ethnic and cultural background can influence chronic pain behavior and coping strategy (40). Therefore, the current results should be interpreted cautiously because racial, ethnic, and socio-economic factors may also play a crucial role in individual differences of pain perception.

Conclusions

In conclusion, women showed increased low back pain and leg pain due to degenerative LSS compared to men. The current study demonstrates that this gender difference can be mediated by differences in pain sensitivity. Furthermore, this study provides insights into pain sensitivity between genders in degenerative lumbar disease for future research, especially regarding the influence of pain sensitivity on the result of various treatment modalities between men and women.

References

1. Racine M, Tousignant-Laflamme Y, Kloda LA, Dion D, Dupuis G, Choiniere M. A systematic literature review of 10 years of research on sex/gender and experimental pain perception - Part 1: Are there really differences between women and men? *Pain* 2012; 153:602-618.
2. Racine M, Tousignant Laflamme Y, Kloda LA, Dion D, Dupuis G, Choiniere M. A systematic literature review of 10 years of research on sex/gender and pain perception - Part 2: Do biopsychosocial factors alter pain sensitivity differently in women and men? *Pain* 2012; 153:619-635.
3. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim-Williams B, Riley JL. Sex, gender, and pain: A review of recent clinical and experimental findings. *J Pain* 2009; 10:447-485.
4. Ishimoto Y, Yoshimura N, Muraki S, Yamada H, Nagata K, Hashizume H, Taki-guchi N, Minamide A, Oka H, Kawaguchi H, Nakamura K, Akune T, Yoshida M. Prevalence of symptomatic lumbar spinal stenosis and its association with physical performance in a population-based cohort in Japan: The Wakayama Spine Study. *Osteoarthritis Cartilage* 2012; 20:1103-1108.
5. Unruh AM. Gender variations in clinical pain experience. *Pain* 1996; 65:123-167.
6. Keefe FJ, Lefebvre JC, Egert JR, Affleck G, Sullivan MJ, Caldwell DS. The relationship of gender to pain, pain behavior, and disability in osteoarthritis patients: The role of catastrophizing. *Pain* 2000; 87:325-334.
7. Müllersdorf M, Söderback I. The actual state of the effects, treatment and incidence of disabling pain in a gender perspective — a Swedish study. *Disabil Rehabil* 2000; 22:840-854.
8. Edwards R, Doleys DM, Lowery D, Fillingim RB. Pain tolerance as a predictor of outcome following multidisciplinary treatment for chronic pain: Differential effects as a function of sex. *Pain* 2003; 106:419-426.
9. Fillingim RB. Sex, gender, and pain: Women and men really are different. *Curr Rev Pain* 2000; 4:24-30.
10. Riley JL, Robinson ME, Wise EA, Myers CD, Fillingim RB. Sex differences in the perception of noxious experimental stimuli: A meta-analysis. *Pain* 1998; 74:181-187.
11. Fillingim RB, Doleys DM, Edwards R, Lowery D. Clinical characteristics of chronic back pain as a function of gender and oral opioid use. *Spine (Phila Pa 1976)* 2003; 28:143-150.
12. Andersson HI, Ejlertsson G, Leden I, Rosenberg C. Chronic pain in a geographically defined general population: Studies of differences in age, gender, social class, and pain localization. *Clin J Pain* 1993; 9:174-182.
13. Amundsen T, Weber H, Lilleås F, Nordal HJ, Abdelnoor M, Magnaes B. Lumbar spinal stenosis. Clinical and radiologic features. *Spine (Phila Pa 1976)* 1995; 20:1178-1186.
14. Katz JN, Harris MB. Clinical practice. Lumbar spinal stenosis. *N Engl J Med* 2008; 358:818-825.
15. Verbiest H. Pathomorphologic aspects of developmental lumbar stenosis. *Orthop Clin North Am* 1975; 6:177-196.
16. Getty CJ. Lumbar spinal stenosis: The clinical spectrum and the results of operation. *J Bone Joint Surg Br* 1980; 62-B:481-485.
17. Fairbank JC, Pynsent PB. The Oswestry Disability Index. *Spine (Phila Pa 1976)* 2000; 25:2940-2952.
18. Sirvanci M, Bhatia M, Ganiyusufoglu KA, Duran C, Tezer M, Ozturk C, Aydogan M, Hamzaoglu A. Degenerative lumbar spinal stenosis: Correlation with

Oswestry Disability Index and MR imaging. *Eur Spine J* 2008; 17:679-685.

19. Ware J, Snow K, Kosinski M, Gandek B. *SF-36 health survey manual and interpretation guide.* New England Medical Center. The Health Institute, Boston, MA 1993.
20. Ruscheweyh R, Marziniak M, Stumpenhorst F, Reinholz J, Knecht S. Pain sensitivity can be assessed by self-rating: Development and validation of the Pain Sensitivity Questionnaire. *Pain* 2009; 146:65-74.
21. Ruscheweyh R, Verneuer B, Dany K, Marziniak M, Wolowski A, Colak Ekici R, Schulte TL, Bullmann V, Grewe S, Gralow I, Evers S, Knecht S. Validation of the Pain Sensitivity Questionnaire in chronic pain patients. *Pain* 2012; 153:1210-1218.
22. Schizas C, Theumann N, Burn A, Tansey R, Wardlaw D, Smith FW, Kulik G. Qualitative grading of severity of lumbar spinal stenosis based on the morphology of the dural sac on magnetic resonance images. *Spine (Phila Pa 1976)* 2010; 35:1919-1924.
23. Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J, Boos N. Magnetic resonance classification of lumbar intervertebral disc degeneration. *Spine (Phila Pa 1976)* 2001; 26:1873-1878.
24. United States Bone and Joint Initiative. *The Burden of Musculoskeletal Diseases in the United States, 2nd ed.* American Academy of Orthopaedic Surgeons, Rosemont, IL, 2011.
25. Brattberg G, Parker MG, Thorslund M. A longitudinal study of pain: Reported pain from middle age to old age. *Clin J Pain* 1997; 13:144-149.
26. Lavsky-Shulan M, Wallace RB, Kohout FJ, Lemke JH, Morris MC, Smith IM. Prevalence and functional correlates of low back pain in the elderly: The Iowa 65+ Rural Health Study. *J Am Geriatr Soc* 1985; 33:23-28.
27. Clauw DJ, Williams D, Lauerman W, Dahlman M, Aslami A, Nachemson AL, Kobrine AI, Wiesel SW. Pain sensitivity as a correlate of clinical status in individuals with chronic low back pain. *Spine (Phila Pa 1976)* 1999; 24:2035-2041.
28. Giesecke T, Gracely RH, Grant MA, Nachemson A, Petzke F, Williams DA, Clauw DJ. Evidence of augmented central pain processing in idiopathic chronic low back pain. *Arthritis Rheum* 2004; 50:613-623.
29. Nielsen CS, Staud R, Price D. Individual differences in pain sensitivity: Measurement, causation, and consequences. *J Pain* 2009; 10:231-237.
30. Shabat S, Folman Y, Arinzon Z, Adunsky A, Catz A, Gepstein R. Gender differences as an influence on patients' satisfaction rates in spinal surgery of elderly patients. *Eur Spine J* 2005; 14:1027-1032.
31. Kim HJ, Suh BG, Lee DB, Lee GW, Kim DW, Kang KT, Chang BS, Lee CK, Yeom JS. The influence of pain sensitivity on the symptom severity in patients with lumbar spinal stenosis. *Pain Physician* 2013; 16:135-144.
32. Bingefors K, Isacson D. Epidemiology, co-morbidity, and impact on health-related quality of life of self-reported headache and musculoskeletal pain—a gender perspective. *Eur J Pain* 2004; 8:435-450.
33. Häkkinen A, Kautiainen H, Järvenpää S, Arkela-Kautiainen M, Ylinen J. Changes in the total Oswestry Index and its ten items in females and males pre- and post-surgery for lumbar disc herniation: A 1-year follow-up. *Eur Spine J* 2007; 16:347-352.
34. McGuigan FX, Hozack WJ, Moriarty L, Eng K, Rothman RH. Predicting quality-of-life outcomes following total joint arthroplasty. Limitations of the SF-36 Health Status Questionnaire. *J Arthroplasty* 1995; 10:742-747.
35. Benroth R, Gawande S. Patient-reported health status in total joint replacement. *J Arthroplasty* 1999; 14:576-580.
36. Tang Y, Yang W, Wang Y, Lin L. Sex differences in the symptoms and psychological factors that influence quality of life in patients with irritable bowel syndrome. *Eur J Gastroenterol Hepatol* 2012; 24:702-707.
37. Kempen GI, Ormel J, Brilman EI, Relyveld J. Adaptive responses among Dutch elderly: The impact of eight chronic medical conditions on health-related quality of life. *Am J Public Health* 1997; 87:38-44.
38. Stewart AL, Greenfield S, Hays RD, Wells K, Rogers WH, Berry SD. Functional status and well-being of patients with chronic conditions. Results from the Medical Outcomes Study. *JAMA* 1989; 262:907-913.
39. Lame IE, Peters ML, Vlaeyen JW, Kleef Mv, Patijn J. Quality of life in chronic pain is more associated with beliefs about pain, than with pain intensity. *Eur J Pain* 2005; 9:15-24.
40. Keefe FJ, Rumble ME, Scipio CD, Giordano LA, Perri LM. Psychological aspects of persistent pain: Current state of the science. *J Pain* 2004; 5:195-211.