

The Evaluation of Bladder Symptoms in Patients With Lumbar Compression Disorders Who Have Undergone Decompressive Surgery

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Study Design.

Prospective cohort study.

Objective. We study the relationship between the degree of dural sac compression, the prevalence of lower urinary tract symptoms, and the effect of surgical decompression in patients with lumbar spinal canal compression using the American Urological Association Symptom Score (AUAss).

Summary of Background Data. Patients with lumbar spinal canal compression not only experienced leg neuropathy but also lower urinary tract symptoms. There are few reports concerning the prevalence of bladder symptoms and the effect of decompression on urinary symptoms.

Methods. We enrolled 245 patients, who were admitted for decompression of lumbar spinal canal compression, using the AUAss. On the basis of the score, patients were divided into 2 groups: those with significant neurologic bladder symptoms (high AUAss), and those without significant symptoms (low AUAss). The narrowest anteroposterior diameter of the dural sac at the corresponding level of decompression on axial magnetic resonance imaging (MRI) was measured for both groups. The Oswestry Disability Index and AUAss were compared before and after decompressive surgery. The urodynamic change in the group of high AUAss after surgery was analyzed.

Results. A total of 67 patients (27%) had significant lower urinary tract symptoms in our study group. The mean/median number of levels decompressed was 1.5/1 in high AUAss and 1.8/2 in low AUAss group. Decompressive surgery had beneficial effect on both the AUAss and Oswestry Disability Index in both groups. The postvoid residual urine volume was significantly reduced after surgical decompression. The narrowest diameter of dural sac on MRI has correlation with AUAss.

Conclusion. We found that 27% patients with lumbar spinal compression disorders had lower urinary tract symptoms; the anteroposterior diameter of dural sac measured on axial MRI is correlated with the lower urinary tract symptoms. After the decompressive surgery, the most sensitive indicator of bladder dysfunction was subjective symptoms and postvoid residual voiding volume.

Key words: neuropathic bladder, lumbar spinal stenosis, lumbar disc herniation, surgical outcome. **Spine 2010; 35:E849–E854**

Patients with lumbar spinal canal compression, such as lumbar spinal stenosis (LSS) or lumbar disc herniation (LDH), not only complain of intractable back or leg pain but also manifest varying degrees of bladder dysfunction. Lower urinary tract symptoms result from compression of the parasympathetic fibers of S2–S4 nerve roots innervating the bladder. A complete neurologic evaluation to exclude herniated disc or spinal stenosis should include the sensory, reflex, and motor testing of the lower limbs and urodynamic study for evaluation of bladder function. However, the prevalence of lower urinary tract symptoms in patients with LSS or LDH varies, according to the literature, because of differences in subjective symptoms and urodynamic abnormalities.^{1–3} There were few studies concerning the urinary symptoms after spinal decompression.⁴ Moreover, few studies have demonstrated a correlation between bladder dysfunction and the degree of stenotic compression of the cauda equina seen on radiologic findings in patients with LDH or LSS.^{1,4,5}

The goal of the present study is to determine the incidence of bladder symptoms in lumbar spinal compressive disorders, correlate these bladder symptoms with radiologic findings, and report on outcomes of surgery in lumbar spinal compressive disorders

Materials and Methods

This is a prospective cohort study. Between October 2006 and January 2008, we enrolled all patients who complained of lower back pain radiating along the lower lumbar and/or sacral root areas on 1 or both sides caused by herniated intervertebral disc or degenerative lumbar disorder at our institution. Every patient signed the consent form, which was approved by our university's Institutional Review Board.

Patients taking medication that may have influenced detrusor or external urethral sphincter function or who had concurrent neurologic or urologic disease, congenital spinal deformity, or former spinal surgery were excluded. The prostate was

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examined in all men and only those with normal prostate findings on palpation were included in the study. A diagnosis of lumbar spinal canal compression because of disc herniation, or spinal stenosis was established by preoperative assessment of sensory, reflex, and motor signs in the lower extremities and verified by magnetic resonance imaging (MRI). All surgical decompression with or without instrumentation was performed by the same spinal surgeon. Laminectomy and discectomy were performed for spinal stenosis; laminotomy and removal of herniated disc were done for disc herniation.

Assessment With Oswestry Disability Index Outcomes

The Oswestry Disability Index (ODI)^{6,7} is a self-administered questionnaire designed to assess pain-related disability in patients with low back pain. For each section of the questionnaire, the patient selects 1 statement that best represents his or her perceived ability to perform a function and/or the quantity of pain experienced on the day of assessment.

Assessment of Lower Urinary Tract Symptoms

The American Urological Association Symptom Score (AUAss) (Table A1, A2) is a self-administered questionnaire with 7 items that measures the frequency of the most important urinary symptom (emptying, frequency, intermittency, urgency, weak stream, hesitancy, and nocturnal polyuria) using an ordinal scale with 6 response options ranging from “never” to “almost always.” The final symptom score ranges from 0 (absence of problems) to 35 (very frequent problems). Scores of 0 to 7 are considered to represent mild symptoms, and 8 to 35 represent moderate-to-severe symptoms. Questions from the AUAss questionnaire concerning incomplete emptying, weak stream, straining with urination, and intermittency of the stream were considered obstructive. A response to questions about frequency of urination, nocturia, and urgency were considered irritative.⁸

Assessment of Compression of Dura

All patients who underwent decompressive surgery received a preoperative MRI (GE Signa HDxt 3.0T MR) survey. The di-

ameter of the dural sac at the corresponding level of decompression on the axial view of T2WI was measured at its narrowest area for comparison.

Outcomes Assessment

The ODI was used for evaluation of back pain. All patients received preoperative assessment which was repeated 3 months later after decompression surgery. The AUAss was used to quantify lower urinary tract symptoms. All patients were evaluated lower urinary tract symptoms with a preoperative AUAss and were followed-up 3 months after decompression surgery with a repeat AUAss. In addition, uroflowmetry was performed before surgery in patients with high AUAss (≥ 8). The postoperative uroflowmetry was further analyzed 3 months later. The postoperative uroflowmetry included maximum voided volume, maximum urine flow rate, and postvoid residual urine volume.

Statistical Analysis

The AUAss was divided into high AUAss (≥ 8) and low AUAss (< 8), to explore the difference between preoperative and postoperative in ODI and AUAss after decompression. Wilcoxon signed-rank test was used to test the difference in AUAss and ODI, preoperatively and postoperatively. Then focusing on the high AUAss group, Wilcoxon signed-rank test was used to analyze the difference of AUA Symptom Index and uroflowmetry study, preoperatively and postoperatively. Spearman's correlation was used to explore the relationship between the narrowest AP diameter of dural sac at the level of decompression and incidence of lower urinary tract syndrome. Correlation coefficients between 0.00 and 0.30 are considered weak, those between 0.30 and 0.70 are moderate, and coefficients between 0.70 and 1.00 are considered high. The receiver operating characteristic (ROC) curve analysis for MRI distance to classify low AUAss and high AUAss was performed. The area under the curve for the ROC between 0.90 and 1.00 is considered excellent, 0.80 and 0.90 is good, 0.70 and 0.80 is moderate, 0.60 and 0.70 is fair, and 0.50 and 0.60 is failed. Statistical analysis

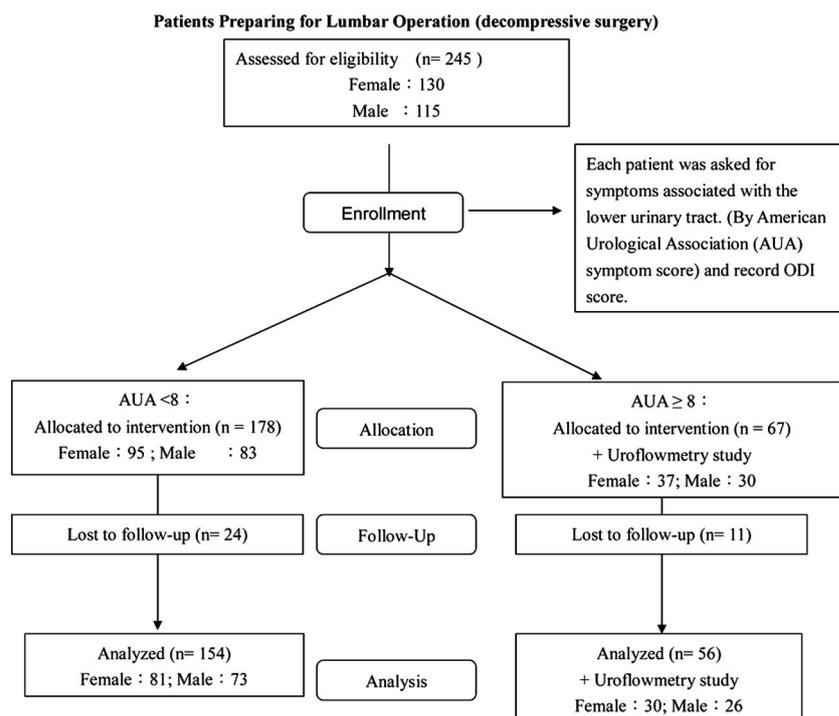


Figure 1. Flowchart demonstrating all 245 patients initially enrolled in the trial and the 210 patients who completed the study.

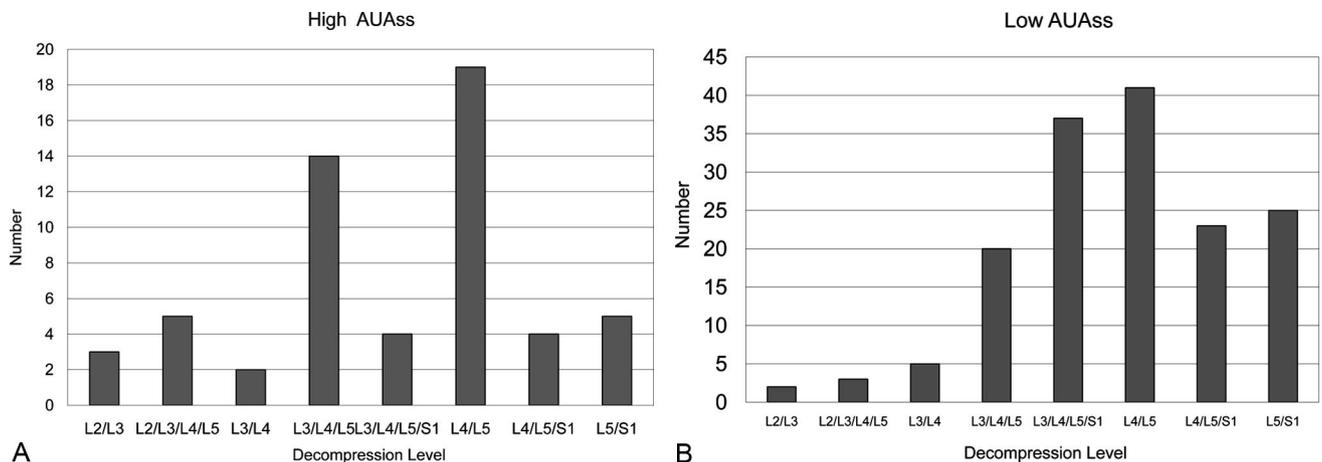


Figure 2. The decompression level in AUAss ≥ 8 group (A) and AUAss < 8 (B).

was performed using SPSS version 12.01 (SPSS, Chicago, IL). A $P < 0.05$ was considered significant.

Results

The patient follow-up is summarized in Figure 1. The 245 patients enrolled in the study included 132 males and 113 females. The average age was 57.4 years (range, 17–80 years). There were 154 patients with AUAss less than 8. There were 30 males and 37 females with AUAss equal to or greater than 8. Therefore, of 245 patients, there were 67 (27.3%) patients with significant lower urinary tract symptoms accompanied by leg pain or neurologic claudication. There were 35 cases lost to follow-up; therefore, a total of 56 cases had high AUAss (AUAss ≥ 8) and 154 cases had low AUAss (AUAss < 8). The median age of the 56 patients was 60.9 years (range, 23–77 years). There are 51 patients with spinal stenosis and 5 with herniated discs in the group with high AUAss. A total of 123 patients had spinal stenosis and 33 had herniated discs with low AUAss; the median age was 55.1 year (range, 20–81 years). The decompression level is shown in Figure 2. The mean/median number of levels decompressed was 1.5/1 in high AUAss and 1.8/2 in low AUAss group.

There was significant improvement in lower urinary tract symptoms after decompression in patients with high AUAss. Improvement in the ODI and AUAss after decompression also occurred in groups with high or low AUAss, as shown in Table 1. Comparing the preoperative and postoperative AUAss, we found significant im-

provement in the score after decompression surgery. The detail of AUAss with significant urinary tract symptoms (AUA ≥ 8) was further analyzed, as shown in Table 2.

Relationship Between Dural Sac Anteroposterior Diameter and AUA Score

The mean diameter of the dural sac in all patients was 5.14 mm. The mean value in patients with high AUAss was 5.81 mm (range, 0.5–14.5 mm), whereas the mean diameter of the dural sac in patients with low AUAss was 4.78 mm (range, 2.58–7.38 mm). The mean dural sac diameter in patients with high AUAss was significantly smaller than the sac diameter found in patients with low AUAss ($P = 0.002$). To evaluate the relationship between the diameter of the dural sac and the incidence of lower urinary tract symptoms, the Spearman's correlation coefficient revealed significant correlation that AUAss decreases with anteroposterior diameter in MRI ($P < 0.001$, $r = -0.239$) (Figure 3A). Although the P value for the Spearman correlation is small ($P < 0.001$), the r value is also small at -0.239 , denoting a low degree of correlation. The ROC curve analysis showed the area under the ROC curves was 0.646 (Figure 3B), meaning a fair degree of discrimination. The specificity and sensitivity according to the cut-off points is shown in Table 3.

Outcomes Assessment

Bladder Symptoms. The AUAss index has questions that include retention/obstructive symptoms (incomplete bladder emptying and straining, weak stream, beach)

Table 1. Patients Divided into Two Groups Based on AUAss

Group	Number	Item	Preoperative Mean \pm SD	Postoperative Mean \pm SD	P
AUAss < 8	154	AUA	2.6 \pm 2.1	2.1 \pm 1.7	$P < 0.05$
		ODI (%)	60.7 \pm 15.3	32.2 \pm 13.4	$P < 0.05$
AUAss ≥ 8	56	AUA	15.9 \pm 5.3	10.9 \pm 6.0	$P < 0.05$
		ODI (%)	55.2 \pm 13.5	34.0 \pm 12.4	$P < 0.05$

Both groups showed significant improvement in ODI and AUAss after decompression.

AUAss indicates American Urological Association Symptom Score; AUA, American Urological Association; ODI, Oswestry Disability Index.

Table 2. Comparison Between AUA Symptom Index and Uroflowmetry Before and After Decompressive Surgery in the Group With AUA Score Greater Than 8

	Preoperation	Postoperation	P
AUA symptom index			
Incomplete emptying	2.8	1.6	<0.001
Frequency	3.2	2.1	<0.001
Intermittency	2.3	1.4	<0.001
Urgency	1.0	0.7	<0.05
Weak stream	2.5	1.7	<0.001
Hesitancy	2.0	1.4	<0.05
Nocturia	2.2	2.0	0.073
Total score	15.9	10.9	<0.001
Uroflowmetry study			
Maximum voided volume (mL)	220.9	250.8	0.436
Maximum urine flow rate (mL/s)	17.3	21.1	<0.05
Postvoiding residual urine volume (mL)	57.8	33.6	<0.05

AUA indicates American Urological Association.

and irritative symptoms (daytime frequency, nocturia, and urgency). All symptoms significantly improved after decompression surgery except nocturia.

Urodynamic Study

Maximum Voided Volume. The average maximum voided volume was 220.9 mL (range, 51–495 mL) before surgery and showed no significant improvement after surgery was performed (mean, 250.8 mL; range, 53–655 mL). The change was not significant in either the male (mean, 235.6–245.9 mL) or the female patients (mean, 207.3–247.0 mL).

Maximum Urine Flow Rate. The average maximum urine flow rate was 17.3 mL/s (range, 4.4–57.1 mL/s) before surgery and showed significant improvement after surgery (mean, 21.1 mL/s; range, 4.6–60.3 mL/s). The change was significant in the female patients (mean,

Table 3. Sensitivity and Specificity in Differentiating AUA >8 and AUA ≤8 at Different Cut-off Value Based on ROC Curve (AUC = 0.646)

MRI Distance (mm)	Sensitivity (%)	Specificity (%)
4.0	18	83
4.5	39	73
5.0	68	58
5.5	84	49
6.0	89	40

AUA indicates American Urological Association; AUC, area under the curve.

24.20–26.83 mL/s; $P = 0.04$), but not in the male patients (mean, 11.89–15.75 mL/s; $P = 0.14$).

Postvoid Residual Urine Volume. The average postvoid residual urine volume was 57.8 mL (range, 0–400 mL) before surgery and showed significant improvement after surgery (mean, 33.6 mL; range, 0–300 mL). The change was statically significant in the male (mean, 68.4–45.6 mL; $P = 0.02$) and female patients (mean, 47.9–22.3 mL; $P = 0.03$).

The uroflowmetry study revealed significant improvement in postvoiding residual urine volume and maximum urine flow, especially in the female patients, but no improvement in maximum voided volume.

Discussion

LSS and LDH may not only cause neurologic claudication but may also result in lower urinary tract disturbances, and the prevalence may vary. Previous reports have shown lower urinary tract symptoms with disc herniation in up to 50% of patients with matching urodynamic findings.⁹ According to the literature, the prevalence of lower urinary tract symptoms associated with LSS ranges from 50% to 80%.^{1–3,5} In this study, 27% of patients complained of significant urological symptoms.

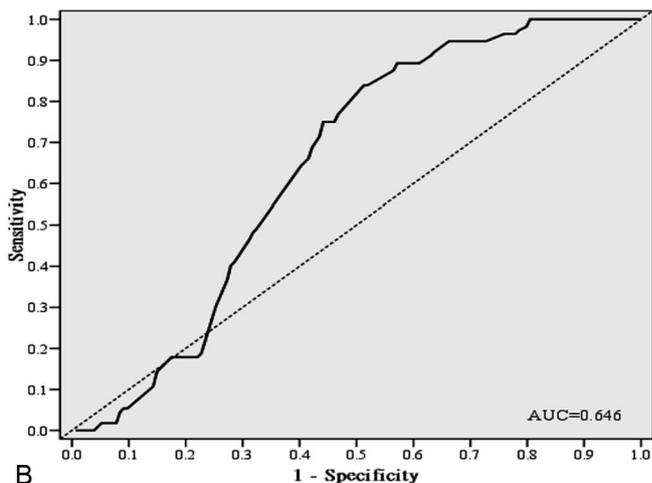
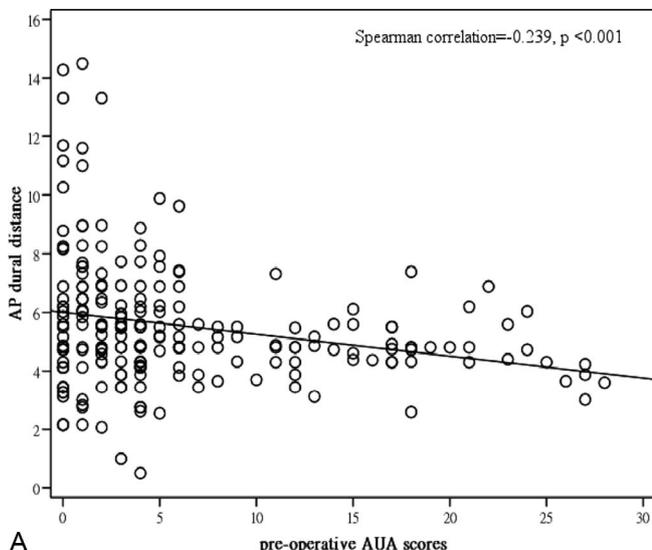


Figure 3. **A**, the association between preoperative AUAs and dural sac anteroposterior diameter. The $r = -0.239$ indicates that AUAs decreases with anteroposterior diameter. **B**, The receiver operating characteristics curve of MRI distance in the classification of AUA ≥ 8 and AUA < 8 area under curve is 0.646.

The variation in prevalence may not only be secondary to the degree of dural compression but also to the manner of assessment of lower urinary tract symptoms. We only performed uroflowmetry in patients with significant bladder symptoms. The prevalence of bladder dysfunction detected objectively by uroflowmetry studies is much higher than the subjective reporting of lower urinary symptoms by patients.

A critical size for the dural sac of patients with significant lower urinary tract symptoms is still debatable. The current study revealed that the narrowest diameter of dural sac on MRI has negative correlation associated with lower urinary tract symptoms score. If the cutoff value was 5 mm, the sensitivity was 58% and specificity 68% in evaluation. We believe that 5 mm may be a reasonable value to warrant lower urinary tract symptoms in patients with lumbar spinal canal compression. Beattie *et al*¹⁰ have defined a dural sac diameter less than 7 mm as central stenosis, using CT, and this anteroposterior diameter is used in their algorithm to assign patients to an impairment category. Inui *et al*⁵ have also shown, using CT myelography, that an 8-mm dural sac AP diameter is an important factor predicting the existence of neuropathic bladder.

The indicator of postoperative neurologic recovery after spinal decompression is controversial. Subjective symptoms and postvoid residual urine volume are considered sensitive indicators of bladder dysfunction after decompression. Improvement in maximum urine flow rate is noted more commonly in female patients as compared with male patients, and our study confirmed the result of the previous reports.^{1,4} Postvoid residual urine volume and maximum urine flow rate are indicators of detrusor function and tone. The improvement in the 2 factors is considered evidence of improved bladder function.

Our study has several limitations. We did not arrange for cystometrography or electromyography in the current study, as some studies have shown that the value of cystometrography and electromyography after decompression surgery is not significant.^{1,11}

In addition, in our study the decompression level varied considerably depending on the patient. We also defined lumbar spinal canal compression as those caused by herniated disc and spinal stenosis. The corresponding decompression method varied depending on the etiology of the compression disorder.

In conclusion, we found that 27% of patients with lumbar spinal compression syndrome had lower urinary

tract symptoms; the anteroposterior diameter of dural sac measured on axial MRI is correlated with the lower urinary tract symptoms. In addition, after decompression, the most sensitive indicator of bladder dysfunction was subjective symptoms and postvoid residual voiding volume. If urodynamic studies for postoperative improvement after decompression surgery are not available, the use of the AUAss may be a valid method.

■ Key Points

- Twenty-seven percent of the patients with lumbar spinal compression disease complained of neurologic bladder symptoms.
- Decompression surgery had a beneficial effect not only on daily performance but also on urological symptoms.
- After decompression, the most sensitive indicator was subjective symptoms and postvoid residual volume.
- The narrowest diameter of dural sac on MRI has significant correlation with AUAss.

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■ TABLES A1, A2

Table A1. AUA Symptom Score (AUAss)

Circle One Number on Each Line	Today's Date:					
	Not at All	Less Than 1 Time in 5	Less Than Half the Time	About Half the Time	More Than Half the Time	Almost Always
Over the past month or so, how often have you had a sensation of not emptying your bladder completely after you finished urinating?	0	1	2	3	4	5
During the past month or so, how often have you had to urinate again less than two hours after you finished urinating?	0	1	2	3	4	5
During the past month or so, how often have you found you stopped and started again several times when you urinated?	0	1	2	3	4	5
During the past month or so, how often have you found it difficult to postpone urination?	0	1	2	3	4	5
During the past month or so, how often have you had a weak urinary stream?	0	1	2	3	4	5
During the past month or so, how often have you had to push or strain to begin urination?	0	1	2	3	4	5
Over the past month, how many times per night did you most typically get up to urinate from the time you went to bed at night until the time you got up in the morning?	None 0	1 Time 1	2 times 2	3 times 3	4 times 4	5 or more times 5

Add the score for each number above and write the total in the space to the right. Total: __.

Symptom Score: 1–7 (Mild), 8–19 (Moderate), and 20–35 (Severe).

AUAss indicates American Urological Association Symptom Score.

Table A2. Quality of Life (QOL)

	Delighted	Pleased	Mostly Satisfied	Mixed	Mostly Dissatisfied	Unhappy	Terrible
How would you feel if you had to live with your urinary condition the way it is now, no better, no worse, for the rest of your life?	0	1	2	3	4	5	6