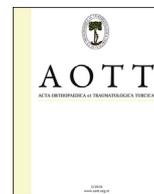




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The tibial nerve compression test for the diagnosis of lumbar spinal canal stenosis—A simple and reliable physical examination for use by primary care physicians



Shu Adachi ^{a,*}, Atsushi Nakano ^b, Akihiro Kin ^c, Ichiro Baba ^b, Yoshitaka Kurokawa ^d, Masashi Neo ^b

^a Department of Orthopedic Surgery, Nishinomiyakoyoritsu Neurosurgical Hospital, Hyogo, Japan

^b Department of Orthopedic Surgery, Osaka Medical College, Osaka, Japan

^c Department of Orthopedic Surgery, Osaka Medical College Mishima-Minami Hospital, Osaka, Japan

^d Department of Orthopedic Surgery, Sato Hospital, Osaka, Japan

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ABSTRACT

Objectives: In the present study, we aimed to evaluate the diagnostic accuracy and suitability of the 'Tibial Nerve Compression Test (TNCT)' as a screening tool for lumbar spinal canal stenosis (LSS).

Methods: A total of 108 consecutive patients admitted to our hospital for surgical treatment or diagnosis of LSS were included in this study. Fifty healthy volunteers were examined as a control group. The severity of tenderness was scored (tenderness score) and measured on a visual analogue scale (P-VAS score). These scores were compared between the LSS and control groups. Moreover, they were compared before and after the operation among operated patients.

Results: The positive tenderness rate was significantly higher (92.6% [100/108]) in the LSS group than in the control group (30% [15/50]). The sensitivity and specificity of TNCT (95% confidence interval) were 0.93 (0.88–0.96) and 0.70 (0.61–0.77), respectively. Positive tenderness rates and P-VAS scores were significantly higher in the LSS group ($p < 0.0001$). Scores on all measures significantly improved post-operatively in operated patients ($p < 0.0001$).

Conclusion: The Tibial Nerve Compression Test is a useful screening tool for LSS diagnosis in a primary care setting.

Level of evidence: Level II, diagnostic study

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Introduction

As the percentage and number of the aged population increases, a corresponding increase will also occur in patients with degenerative spinal disorders, as typified by lumbar spinal canal stenosis (LSS).^{1,2} Consequently, primary care physicians will increasingly examine patients with LSS and will need to diagnose effectively for this condition. However, very few objective physical examinations for diagnosing LSS are available, and various imaging modalities

must be used to achieve a diagnosis. Moreover, no useful physical examination with high sensitivity and specificity for diagnosing LSS has been developed.³

LSS is generally suspected based on a history of symptoms (e.g., pain, numbness, and warmth of the buttocks and legs) and resultant intermittent claudication. If the patient condition fulfills these general criteria, detailed imaging examinations, such as radiography and magnetic resonance imaging (MRI) of the lumbar spine, are performed to check the area of the lumbar spinal canal and are used to provide the basis of a definitive diagnosis. Of the imaging modalities, MRI of the lumbar spine is the most commonly used technique for diagnosing LSS. However, in the primary setting, this imaging technique is not immediately available, and both the time commitment and costs represent general concerns. Hence, primary care physicians must often decide whether to order a lumbar spine

* Corresponding author. Department of Orthopedic Surgery, Nishinomiyakoyoritsu Neurosurgical Hospital, 11-1 Imazu-Yamanakacho, Nishinomiya, Hyogo, Japan.

E-mail address: adachi5412@gmail.com (S. Adachi).

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MRI for patients with leg symptoms based only on a history of the above-mentioned symptoms. Meanwhile, the symptoms of LSS (e.g., pain and numbness) are nonspecific and are observed in other diseases, such as peripheral artery disease and diabetic peripheral neuropathy. Furthermore, the presence of a narrow spinal canal on imaging examinations is often a nonspecific diagnostic trait and not sufficiently reliable for diagnosis.^{4,5} Because of these particular issues, spine surgeons and neurologists can also have trouble in determining whether symptoms of the lower extremities result from LSS, other diseases, or a combination of causes. Hence, the development of a diagnostic physical examination for LSS is strongly needed.

In patients with sciatica, tenderness occurs at the Valleix points in the sciatic notch and in the posterior part of the thigh and surface of the leg along the course of the sciatic nerve.⁶ It could be anticipated that tenderness at the Valleix points will be detected in the legs of not only patients with sciatica due to disc herniation but also those with LSS. A preliminary study recently evaluated four tender points in the lower extremities and buttocks along the sciatic nerve in LSS patients, and found the severity of the tenderness at the popliteal tibial nerve was significantly higher than that at the other three points. This physical examination was termed the “Tibial Nerve Compression Test” (TNCT).⁷ The present study aimed to evaluate the usefulness of the TNCT for the diagnosis of LSS.

Materials and methods

Study participants

Patients who were referred to our department because of numbness, pain, and intermittent claudication in the lower extremity were examined by spine surgeons approved by the Japanese Orthopaedic Association (JOA). The diagnosis of LSS was made based on clinical symptoms confirmed by MRI and myelography. A total of 108 consecutive patients (53 men, 55 women) admitted to our hospital for the treatment of LSS between January 2010 and June 2011 were included in the present study. Exclusion criteria were peripheral artery disease, polyneuropathy, or other musculoskeletal impairments such as osteoarthritis of the hip or knee joint and rheumatoid arthritis. The average age of the study patients was 68.5 years (range, 32–84 years). Seventy-three patients underwent a surgical procedure for LSS, while the remaining 35 patients did not receive a surgical procedure subsequent to the examinations confirming LSS. Moreover, we examined a control group of 50 individuals (33 men, 17 women). The average age of the control group was 36.5 years (range, 21–76 years).

This study was approved by the ethics committees of the participating research institutions of Osaka Medical College. All patients gave their written informed consent for participation in the study.

TNCT

TNCT was conducted with the patient in the prone position. The knee joints were slightly flexed both to loosen the fascia and to enable easy compression of the tibial nerve. The tibial nerve, which is positioned in the deep region of the medial head of the gastrocnemius, was compressed using the thumb at the level of the fibular head at 1–2 cm distal to the knee joint level in the popliteal fossa (Fig. 1). Pulsation at the popliteal artery can serve as a good indicator of the tibial nerve location because the tibial nerve runs along the popliteal artery. In the primary setting, the pressure should be applied with a compression power of 3–4 kgf, which is

Left-knee popliteal region

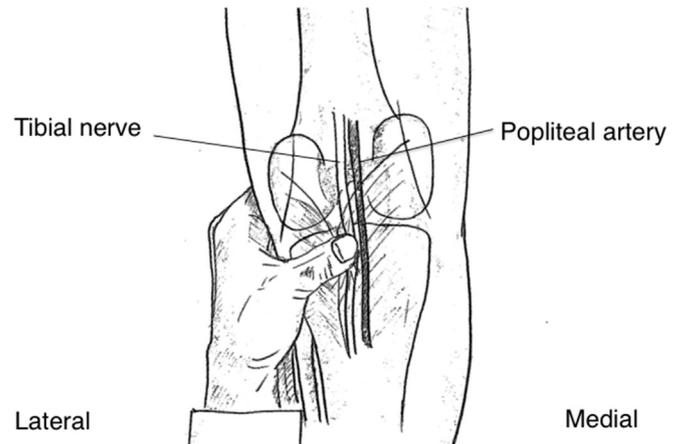


Fig. 1. The tibial nerve compression test.

evidenced by the color of the examiner's thumbnail bed changing from flesh-colored to white.⁸ However, in the present study, we applied pressure using a digital force gauge with a thumb-sized silicone rubber on the tip (Japan Counting System Inc., Sakurai, Japan). The digital force gauge was used with a power of 4 kgf to increase the reproducibility of the test.

The severity of tenderness during the compression test (the tenderness score) was graded on the following 4-grade scale based on the American College of Rheumatology (ACR) tender point criteria for the diagnosis of fibromyalgia: 0 = no pain; 1 (mild) = complaint of pain without grimacing, flinching, or withdrawal; 2 (moderate) = pain plus marked grimacing or flinching; 3 (severe) = pain plus marked flinching and withdrawal.⁹ The tenderness was defined as positive when the ACR scale was at grade 2 or 3, and the positive rate was calculated (tenderness positive rate). The visual analog scale score (P-VAS, 0–100 mm) was also assessed immediately after the compression test, with a higher value indicating increased pain levels.

Analytic methods

The tenderness score, tenderness positive rate, and P-VAS score were compared between the LSS and control group and between the pre-operative status at 1 week and postoperative status at 3–6 months for the operated patients. Furthermore, the clinical outcomes for the patients who underwent a surgical procedure were evaluated with the JOA scoring system for low back pain syndrome (Table 1)¹⁰ at about 1 week pre-operatively and 3–6 months post-operatively.

We calculated the sensitivities, specificities, and likelihood ratios (LRs) for TNCT. Intra-observer reliability was assessed by re-evaluating a random subsample of 25 patients and controls after at least a 1-week interval. The re-evaluation was performed by a senior author of the present paper (A.N.: a board-certified spine surgeon approved by JOA with 16 years of clinical experience). A.N. and one additional independent rater (Y.K.: a member of JOA with 6 years of clinical experience) re-evaluated a random subsample of 50 patients and controls for the assessment of inter-observer reliability.

The χ^2 test was used to assess differences in the proportions between groups. The Wilcoxon rank sum test and Tukey–Kramer honest significant difference test were used for the analysis of differences in continuous variables. A p-value of <0.05 was

Table 1
The Japanese Orthopedic Association's evaluation system for lower back pain syndrome (JOA Score).

I. Subjective symptom (9 points)			
A. Low back pain			
(a) None			3
(b) Occasional mild pain			2
(c) Frequent mild or severe pain			1
(d) Continuous severe pain			0
B. Leg pain and/or tingling			
(a) None			3
(b) Occasional mild symptom			2
(c) Frequent mild or severe symptom			1
(d) Continuous severe symptom			0
C. Gait			
(a) Normal			3
(b) Able to walk farther than 500 m despite pain, tingling, and/or muscle weakness			2
(c) Unable to walk farther than 500 m because of pain tingling and/or muscle weakness			1
(d) Unable to walk farther than 100 m because of pain tingling and/or muscle weakness			0
II. Objective symptom (6 points)			
A. Straight leg raising			
(a) Normal			3
(b) 30°–70°			2
(c) <30°			1
B. Sensory disturbance			
(a) None			3
(b) Slight disturbance			2
(c) Marked disturbance			1
C. Motor disturbance			
(a) Normal (grade 5)			3
(b) Slight weakness (grade 4)			2
(c) Marked weakness (grade 0–3)			1
III. Restriction of activities of daily living (14 points)			
	Severe	Moderate	None
Turning over while lying	0	1	2
Standing	0	1	2
Washing	0	1	2
Leaning forward	0	1	2
Sitting (1 h)	0	1	2
Lifting or holding	0	1	2
Walking	0	1	2
IV. Urinary bladder function (–6 points)			
(a) Normal			0
(b) Mild dysuria			–3
(c) Severe dysuria			–6
Total			29 point

considered statistically significant. Statistical analyses were performed using JMP Pro10 software (SAS Institute Inc., Cary, NC).

Results

The tenderness positive rate was 92.6% (100/108) for the LSS group as compared to 30% (15/50) for the controls. Moreover, the average tenderness and P-VAS scores were 2.28 and 72.6 mm for the LSS group, respectively, as compared to 0.98 and 22.5 mm for the controls. The values of all three evaluation items were significantly different between the LSS group and controls ($p < 0.0001$; Fig. 2). The sensitivity and specificity of TNCT (95% CI) was 0.93 (0.88–0.98) and 0.70 (0.57–0.83), respectively. Meanwhile, the positive and negative LR were 3.1 (2.24–4.12) and 0.10 (0.06–0.19), respectively.

In terms of intra-observer reliability, agreement was observed in the rating of 19 individuals from the random subsample of 25 patients and controls between the first and second examinations by the primary investigator (intra-observer kappa, 0.76). Additionally, agreement occurred in the rating of 44 of the 50 randomly selected patients and controls between the two evaluators (inter-observer kappa, 0.88).

In the operated patients, the postoperative status of all three evaluation items for tenderness was significantly improved as compared to the pre-operative status ($p < 0.0001$; Table 2). In the operation group, the JOA score (full score: 29 points) of all patients improved from an average of 16.3 points (range, 7–27 points) pre-operatively to an average of 26.2 points (range, 14–29 points) post-operatively.

Discussion

In the present study, TNCT was shown to have high sensitivity (0.93) and moderate specificity (0.7). This sensitivity was higher than that reported for other physical examinations of LSS (Table 3).^{11,12}

The presence of tender points along the course of a nerve has been well known for cases of neuralgia since Valleix's report in 1841.⁶ Valleix points are those points at which 1) the nerve emerges from the bony canal or pierces a muscle or aponeurosis to reach the skin, 2) a superficial nerve rests upon a resisting surface, 3) compression easily occurs, and 4) the nerve gives off one or more branches or terminates in the skin. In the presence of lumbar nerve root irritation, deep pressure on specific points along the course of the sciatic nerve or its branch may cause pain. These points are the central zone of the buttocks, middle portion of the posterior aspect of the thigh, the head of the fibula, the central zone of the calf, and the region of the Achilles tendon. Sciatic Valleix points have been well described previously as an indicator of lumbar nerve root irritation.¹³

The presence of tenderness at the Valleix points most often occurs in patients with nerve root involvement such as lumbar disc herniation.¹³ However, the Valleix points had not been evaluated for patients with LSS. In the preliminary study of Valleix points in LSS patients,⁷ the severity of the tenderness was evaluated by the tenderness positive rate and average tenderness score, and the results were as follows: the superior gluteal nerve lateral to the posterior superior iliac spine: 36.6% and 0.71, respectively; the sciatic nerve at the greater sciatic foramen: 30.5% and 0.55; the tibial nerve in the popliteal fossa, 93.4% and 2.1; and the common fibular nerve at the posterior head of the fibula, 17.1% and 0.31. The severity of tenderness at the popliteal tibial nerve was significantly higher than that at the other three points ($p < 0.0001$).

Several possibilities could potentially explain the greater sensitivity of the Valleix point of the tibial nerve in the popliteal fossa relative to that of the other Valleix points. First, the tibial nerve in the popliteal fossa runs through the superficial portion of the body and is easily palpable. Second, it is located immediately above the flat and hard base of the posterior tibia, allowing pressure to be effectively applied to it. Third, it runs along the popliteal artery, and the pulsation of this artery enables it to be a good anatomical landmark for identifying the tibial nerve. Finally, the tibial nerve consists of spinal nerve roots from the L4 to S3 levels, and these levels of the spinal nerve roots are often included in the causal nerve root levels of LSS. Collectively, these anatomical features might underlie the high sensitivity of this test.

In the present study, we observed good intra-observer reliability and excellent inter-observer reliability for TNCT, indicating that this test has high objectivity and reproducibility and that the results can be readily compared between different examiners. Moreover, the test is easily performed and can be efficiently integrated into a standard office examination. Hence, in the primary care setting, the TNCT could potentially be used by physicians to decide whether patients with pain, numbness of legs, and intermittent claudication have LSS and to determine whether MRI should be ordered or patients should be referred to spine surgeons. Furthermore, we showed the severity of the tenderness, together with the JOA

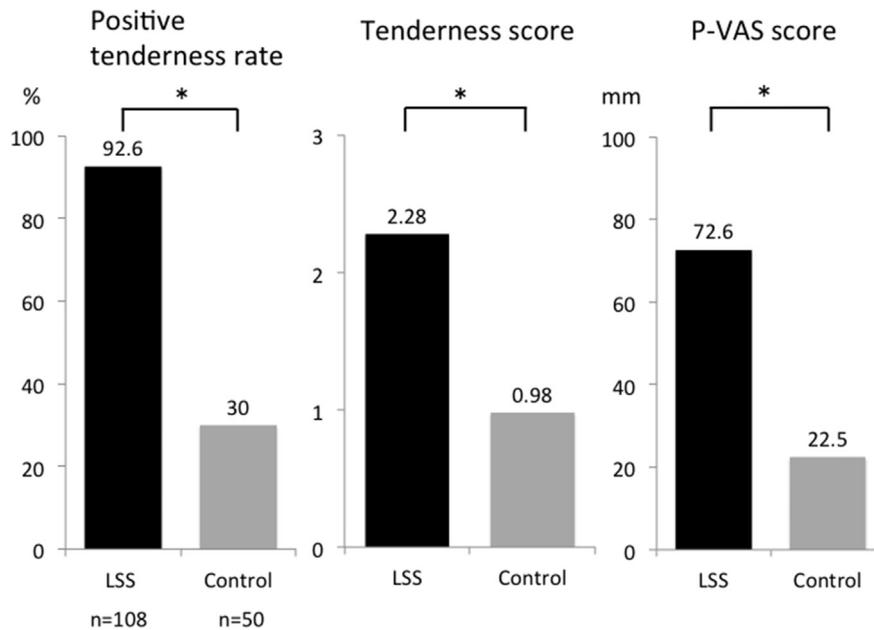


Fig. 2. Evaluation of tenderness between the LSS and control groups. * $p < 0.0001$.

Table 2

Evaluation of tenderness between the preoperative and postoperative status of the operated patients.

Evaluation item	Pre-operation	Post-operation	P
Tenderness positive rate (%)	93	26	<0.0001
Tenderness score	2.3	0.8	<0.0001
P-VAS (mm)	72	31	<0.0001
JOA score	16.3	26.2	<0.0001

scores, improved remarkably after the operation. Hence, the TNCT results responded strongly to decompression of a nerve root or the cauda equina. The severity of the tenderness is suggested to reflect the compressed nerve condition in the spinal canal. Based on these collective findings, TNCT could be a useful clinical examination test for LSS patients in the primary care setting. Combined with other clinical diagnosis support tools (11), TNCT could be used to diagnose LSS more accurately.

This study had several limitations. First, the average age of patients with LSS was higher than that of the controls, and MRI of the lumbar spine could not be performed for the control group. The incidental imaging of LSS on spinal MRI is common in asymptomatic older adults. To avoid the influence of asymptomatic LSS, most of the control group consisted of young people. This difference

might have affected the results of the present study. Second, this study was performed in a spine specialty outpatient clinic in a medical college hospital, and the test was performed by orthopedic surgeons. It remains unclear if primary care physicians would obtain the same results. Furthermore, the patient population would be different from that of a primary care setting. Here, the exclusion criteria were peripheral arterial disease, polyneuropathy, or other musculoskeletal impairments such as osteoarthritis of the hip or knee joint. However, in primary care settings, patients with these diseases visit clinics, and the symptoms of some patients might be caused by mixed lesions and not only LSS. The usefulness of TNCT for evaluating such patients remains unclear, and further validation of TNCT for these types of patients is necessary. Third, TNCT was assessed in situations in which the clinicians knew whether patients had LSS; therefore, the performance of TNCT may be overestimated. TNCT needs to be validated in future studies and requires evaluation in a blinded study. Finally, TNCT was assessed by using a digital force gauge to increase the reproducibility of the test, but in the primary care setting, TNCT is performed with the thumb. Therefore, further studies will need to assess the TNCT with the use of the thumb.

In conclusion, this study demonstrated that TNCT had high sensitivity and specificity and intra- and inter-observer reliability. These findings suggest that this test will be a useful examination for

Table 3

Diagnostic accuracy of patient history characteristics, physical examinations, and the LSS diagnostic support tool in the diagnosis of LSS.

	Sensitivity (95% CI)	Specificity (95% CI)	Positive LR (95% CI)	Negative LR (95% CI)
History features				
Neurogenic claudication ^a	0.82 (0.77–0.87)	0.78 (0.73–0.83)	3.7 (2.9–4.8)	0.23 (0.17–0.31)
Urinary disturbance ^a	0.14 (0.09–0.19)	0.98 (0.96–1.0)	6.9 (2.7–17)	0.88 (0.83–0.93)
Physical examination				
Tibial nerve compression test^b	0.93 (0.88–0.96)	0.7 (0.6–0.77)	3.1 (2.2–4.1)	0.1 (0.06–0.19)
Wide-based gait ^c	0.42 (0.27–0.57)	0.97 (0.91–1.0)	13 (1.9–95)	0.6 (0.46–0.78)
Abnormal Romberg test result ^c	0.4 (0.25–0.54)	0.91 (0.81–1.0)	4.2 (1.4–13)	0.67 (0.51–0.87)
LSS diagnostic support tool ^a	0.93	0.72	3.3	0.1

Bold values indicate results of Tibial nerve compression test in the present study.

^a Konno et al.¹¹

^b The present study.

^c Katz et al.¹²

LSS and help primary care physicians decide whether to order precise imaging examinations and to refer patients to spine surgeons.

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