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**EDITORIAL**

- 20 Current challenges in diagnosis of lumbar radiculopathy

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## Current challenges in diagnosis of lumbar radiculopathy

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### Abstract

Lumbar radiculopathy (LR) is a term used to describe a pain syndrome caused by compression or irritation of nerve roots in the lower back. The surgery cost for LR increased by 23% annually during 1992-2003 in the developed country. Although it is one of most common complaints in clinical practice, the diagnosis for LR is still very challenging. Here we discuss the current tools of LR diagnosis and highlight the needs to develop new diagnosis tools for LR.

**Key words:** Magnetic resonance imaging; Nerve root; Pain; Lumbar radiculopathy; Lateral stenosis

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**Core tip:** Lumbar radiculopathy (LR) is a pain syndrome caused by the compression or irritation of nerve roots in the lower back. Because the diagnosis of LR remains challenging, the development of new diagnostic tools is urged.

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### INTRODUCTION

Lumbar radiculopathy (LR) is a term used to describe a pain syndrome caused by the compression or irritation

**Table 1 Agreement and prediction accuracy between diagnosis tools for detecting the involvement of the nerve root**

	Agreement			Prediction		
	Clinical findings	MRI	MRI and clinical findings	Pain relief after surgical decompression	MRI	Clinical findings
Electrophysiology	52.0% <sup>[2]</sup> 89.5% <sup>[6]</sup>	59.6% <sup>[2]</sup> 54.0% <sup>[6]</sup> 60.0% <sup>[8]</sup>	25.0% <sup>[9]</sup>		Sen: 68.90% Sen: 86.3% <sup>[26]</sup>	
MRI	58.6% <sup>[6]</sup> 30.0% <sup>[7]</sup> 16.3%-64.9% <sup>[4]</sup> 3.0%-22.0% <sup>[5]</sup>	N/A	N/A	N/A	N/A	Spe: 16.0%-37.0% Spe: 61.0%-77.0% <sup>[27]</sup>
SNB	N/A	N/A	N/A	Sen: 85.40% Spe: 16.7% <sup>[10]</sup> Sen: 93.00% Spe: 26.0% <sup>[11]</sup> Sen: 96.00% Spe: 56.0% <sup>[12]</sup>		

MRI: Magnetic resonance imaging; SNB: Selective nerve block; N/A: Not available; Sen: Sensitivity; Spe: Specificity.

of nerve roots in the lower back. The cost of surgery for LR increased by 23% annually from 1992 to 2003 in the developed world<sup>[1]</sup>. Although it is among the commonest complaints in clinical practice, diagnosing it remains challenging. Here, we discuss the current tools for LR diagnosis and highlight the need to develop new diagnostic tools for LR.

#### **Requirements for an accurate diagnosis of LR**

Accurate diagnosis is advantageous for treatment outcomes, with the ultimate aim of post-treatment pain relief. For the successful operative treatment of LR, a surgeon must identify the location that causes pain.

#### **Inconsistency between diagnostic tools for anatomical localization**

No gold standard exists for detecting the involved nerve root of LR. The diagnostic tools include symptomatology, physical examinations, electrodiagnostic study (EDX), magnetic resonance imaging (MRI), and selective nerve block (SNB). Currently, a combination of 2 or more of these techniques is generally used to obtain a diagnosis. However, inconsistency between these diagnostic tools is common and may cause confusion<sup>[2,3]</sup>. Dermatomal pain distribution is generally regarded as the first indication that the nerve root is involved. However, this indication is unreliable; only 16.3% of patients with L5 radiculopathy report a corresponding dermatomal pain distribution<sup>[4]</sup>. Moreover, only 3%-22% of patients with nerve root compression confirmed through intraoperative exposure had a corresponding dermatomal pain distribution<sup>[5]</sup>. Although physical examinations enhance LR diagnosis efficacy, conclusions of symptomatology and physical examination are consistent with MRI findings in only 16%-58% of patients with LR<sup>[4,6,7]</sup>. Greater consistency could be obtained by combining clinical findings and EDX<sup>[2,6]</sup>, but abnormalities in EDX were observed in fewer than 50% of patients with LR<sup>[3]</sup>. For determining nerve root involvement, MRI is markedly sensitive but exhibits a low specificity. By contrast, EDX

is markedly specific but has a low sensitivity. Therefore, MRI and EDX are currently considered complementary tools for identifying which nerve root is involved in LR. However, inconsistent findings from MRI and EDX are common, with an agreement rate of between 25% and 60%<sup>[2,6,8,9]</sup>. SNB is usually employed as a diagnostic tool in patients with inconsistent findings to predict postoperative outcome. The sensitivity of SNB for a favorable postoperative outcome may reach 85%-96%, but it has a specificity of 16%-56%<sup>[10-12]</sup> (Table 1).

These inconsistencies reflect the limitations of each diagnostic tool. Crucially, these tools do not directly evaluate pain or nociception. The conventional sensory test elucidates patients' perception of peripheral sensations, but it does not evaluate nociception. Although an MRI may provide anatomical evidence of nerve compression, the compression of a nerve root does not necessarily cause pain. An EDX can detect denervation or regeneration of the involved nerve root, but it provides limited information on nociception. To overcome the difficulty in determining nerve root involvement in patients with LR, a prediction model combining 2 or more of these diagnostic tools may provide more accurate results<sup>[13,14]</sup>. A prediction model that included findings from MRI, symptomatology, physical examination, and SNB was developed and validated to predict the likelihood of a favorable 2-year outcome after decompression surgery<sup>[15]</sup>. Notably, this prediction model did not include EDX and emphasized the role of the pain visual analog scale (VAS) and its response after SNB. Although the pain VAS is objective, it directly reflects a patient's response to nociception. The advantage of this prediction model is that it treats a favorable 2-year outcome as the gold standard. Nevertheless, a favorable outcome is the goal of any diagnostic tool.

#### **Development of tools for the detection of dorsal root ganglion involvement**

The dorsal root ganglion or its surrounding nerve tissue is involved in lateral spinal canal stenosis (also known

as lateral stenosis). An accurate diagnosis should not only reveal which root is involved but also identify the segment (*e.g.*, postganglionic or postganglionic) of the nerve root that is compressed. Currently, sensory nerve action potential (SNAP) and the standardized qualitative sensory test (SQST) are diagnostic tools for detecting lateral stenosis. A 50% decrease in SNAP amplitude of the superficial peroneal nerve on the affected side (compared with the unaffected side) has a sensitivity of 91.3% with a specificity of 85.7% for detecting lateral canal stenosis<sup>[16]</sup>. The SQST combined with an MRI is also a valuable tool for diagnosing lateral stenosis and identifying the compressed segment of the back<sup>[17]</sup>. SNAP and SQST appear to be promising for discriminating between lateral stenosis and central stenosis in patients with LR. However, SNAP abnormality was observed in only 2% of patients with LR<sup>[18]</sup>; SQST requires the full cooperation of patients and is validated only in patients with L5 radiculopathy<sup>[17]</sup>. Additional studies are required to optimize these diagnostic tools to enhance their efficacy or develop novel tools.

#### **Lack of mechanism-based diagnostic tools**

Pain is the most disturbing symptom in patients with LR. Determining the mechanism by which pain is generated in patients with LR is critical for choosing treatment options. Different types of pain require different treatments. Persistent pain after an accurate diagnosis and even adequate surgical decompression is not uncommon<sup>[19,20]</sup>. Some types of LR-associated pain (*e.g.*, neuropathic pain) do not respond to surgical decompression<sup>[20]</sup>. Substantial evidence from animal studies has shown that simply touching the nucleus pulposus without applying any pressure on the nerve root can cause pain-like behaviors in rodents<sup>[21-23]</sup>. Thus, optimal diagnosis tools should not only reveal the exact anatomical location of the pathology but also the pain mechanism for patients with LR. The types of LR-associated pain include mechanical, ischemic, inflammatory, and neuropathic pain<sup>[24]</sup>. Current diagnostic tools are insufficiently sensitive to distinguish between specific pain phenotypes.

#### **Diagnostic tools that directly evaluate nociceptive pathways or pain phenotypes**

Currently, few tools address pain phenotypes associated with LR. Interview questionnaires (*e.g.*, neuropathic pain questionnaires, ID pain, and Pain DETECT) are used to detect neuropathic pain components. Allodynia and windup phenomena in quantitative sensory tests are markers of neuropathic pain<sup>[25]</sup>. A positive straight leg raise test may be used to identify the mechanical or ischemic pain components<sup>[26]</sup>. In older adults with low back pain, inflammatory biomarkers are associated with pain intensity and could thus play a role in detecting inflammatory pain in patients with LR<sup>[27]</sup>. However, the diagnostic accuracy of the aforementioned tools has not yet been validated, thus undermining their potential for determining treatment options for patients with

LR. Future studies should examine the mechanisms underlying pain associated with LR. Based on the understanding of pain mechanisms, an ideal diagnostic tool can be developed to evaluate nociception or determine specific pain phenotypes.

## CONCLUSION

Diagnosing LR is challenging for surgeons due to the inconsistencies between diagnosis tools and the limited availability of tools for pain phenotyping. It is hoped that further research will be conducted to develop diagnostic tools specifically for LR and associated pain phenotypes.

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