

# The Electrodiagnostic Evaluation of Radiculopathy

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## KEYWORDS

- Electromyography • Radiculopathy • Electrodiagnosis
- Spinal stenosis

The clinical diagnosis of radiculitis indicates limb pain emanating from a spinal nerve or spinal nerve root. Objective findings of strength or reflex deficits or electrodiagnostic changes suggest nerve root dysfunction termed *radiculopathy*. Although commonly caused by structural lesions, such as a herniated nucleus pulposus or degenerative spondylosis, radiculopathy can also be caused by inflammatory, infectious, or malignant disorders.<sup>1</sup> Structural causes of radiculopathy may be readily apparent through common imaging modalities, such as MRI or computed axial tomography.<sup>2</sup> However, MRI is associated with a significantly high false-positive rate in asymptomatic individuals and increases with age.<sup>3,4</sup> In such equivocal cases, imaging may be complemented by electrodiagnostic testing. Electrodiagnostic testing is a functional evaluation of the nervous system. Electrodiagnostic testing also has the added benefit of allowing objective documentation of the chronicity and severity of peripheral nervous system disease.<sup>5</sup>

## DEFINITION

Electrodiagnosis is a broad term encompassing multiple electrodiagnostic techniques, including needle electrode examination (NEE); motor and sensory nerve conduction studies (NCS), including late responses; and evoked potentials. These tests are frequently used in various combinations in the evaluation of radiculopathy primarily to rule out other disorders in the peripheral and central nervous system; however, the NEE is considered the crucial component in the electrodiagnostic evaluation of radiculopathy. To meet the electrodiagnostic criteria for a radiculopathy, abnormalities must be demonstrated in at least 2 muscles innervated by the same nerve root but different peripheral nerves with no abnormalities detected in muscles innervated by the adjacent nerve roots.

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The authors have nothing to disclose.

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## HISTORY AND EXAMINATION

The symptoms of many musculoskeletal and peripheral nerve disorders overlap with the clinical presentation of radiculopathy, therefore electrodiagnostic testing may be ordered for these populations to aide in establishing a diagnosis. Electrodiagnostic testing is not infallible and may be painful and expensive, therefore, as with many other forms of advanced diagnostic testing, electrodiagnosis should only be used as an extension of the history and physical examination. There have been studies done to evaluate the relationship between physical examination and electrodiagnostics. When 170 subjects were referred to an electrodiagnostic laboratory, 32% were diagnosed with a musculoskeletal disorder by standardized physical examination.<sup>6</sup> However, of those subjects with normal electrodiagnostic studies, the prevalence of musculoskeletal disorders increased to 55%. When there was electrodiagnostic evidence of radiculopathy, the presence of a musculoskeletal disorder was still 21%. The significant overlap between the presence of lower-extremity musculoskeletal disorders and lumbosacral radiculopathy suggests that the presence or absence of a musculoskeletal diagnosis does not accurately predict which patients will have normal electrodiagnostic studies.<sup>6</sup> In another study Lauder and colleagues<sup>7</sup> calculated sensitivities, specificities, and predictive values of various symptoms and signs for those with an abnormal electrodiagnostic study. No historical feature was found to be significantly associated with an abnormal electrodiagnostic study. The most sensitive historical feature was the presence of radicular leg pain (86%), though this symptom had a specificity of only 12%. The investigators evaluated several physical examination findings and found the following sensitivities and specificities (sensitivity/specificity): reduced vibration or pinprick sensation (50%/62%), Achilles or patellar reflex deficit (25%/87%), weakness of any muscle (69%/53%), and positive straight leg raise (21%/87%). However, in subjects that had any 4 abnormal physical findings there was a greater than 6 times likelihood that the electromyogram (EMG) study would be abnormal when compared with cases with a normal physical examination.

As with lumbosacral radiculopathies, the value of the history and physical examination in predicting cervical radiculopathies has also been studied.<sup>8</sup> Subjects with symptoms of numbness, tingling, and subjective weakness were more than twice as likely to have abnormal electrodiagnostic testing.<sup>8</sup> Unfortunately, none of these symptoms were significant for radiculopathy specifically. In contrast, the presence of weakness, abnormal reflexes, or abnormal sensation on physical examination indicates a greater than 4 times likelihood of having an abnormal electrodiagnostic study, with a greater than 2 times likelihood of confirming a cervical radiculopathy. A particularly valuable physical examination finding is an abnormal biceps reflex, which increases the odds ratio of making an EMG diagnosis of cervical radiculopathy to 10. In general, the combination of having weakness and a reduced reflex was a strong predictor of both an abnormal electrodiagnostic study, including radiculopathy specifically. Notably, up to 48% of individuals with abnormal electrodiagnostic results will have a normal physical examination, emphasizing the physical examination's relative lack of sensitivity when using electrodiagnosis as a gold standard.

## NERVE ROOT VARIATION

As previously described, the electrodiagnosis of radiculopathy relies upon a myotomal pattern of abnormalities found on NEE. However, variation in the anatomic pattern of nerve roots is known to exist and must be accounted for in the interpretation of the NEE. A study of 200 spontaneously aborted fetuses revealed 107 (53.5%) to show significant variation from the most common arrangement of the brachial plexus.<sup>9</sup>

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