

Original Article

Electromyography in musculoskeletal pain: A reappraisal and practical considerations

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Abstract

Background: Patients with musculoskeletal pain (MSP) and local tenderness in the back and extremities are frequently referred to electromyography (EMG) laboratory to assess the integrity of the spinal nerve roots, peripheral nerves, and skeletal muscles. When focal muscle weakness and anatomical sensory deficits are clinically evident, this procedure is almost always abnormal. In some situations, when the presenting symptoms consist of local pain and tenderness without neuromuscular deficits, its diagnostic utility becomes questionable as illustrated in the present study.

Methods: EMG findings of 75 patients referred for evaluation of local MSP and tenderness in the neck and lower back and in the upper and lower extremities were reviewed. These patients were selected from a group of 200 patients referred for evaluation of unilateral local pain and tenderness in various parts of the body. All EMG procedures and clinical neurologic examination were performed by the author and all underwent magnetic resonance imaging of the affected parts of the body prior to the procedure. None of the 75 patients studied had concurrent medical disorders or had previous spinal root injuries or surgeries to the spine.

Results: All 75 patients in this study showed normal EMG of the affected extremities and normal peripheral nerve conduction study. Those with herniated disc in the cervical or lumbar spine presenting with local pain and tenderness in the neck and lower back but without neurologic deficits or clear radicular symptoms, had normal study also. The remaining 125 patients excluded from the study, had various EMG and peripheral nerve abnormalities that can be attributed to concurrent medical disorders and previous injuries to the spinal roots.

Conclusions: Use of EMG in the diagnosis of local MSP, unless associated with clinical neurologic deficits, almost always yields negative results. The utility of this procedure is limited to pathology in the motor unit. It cannot assess the function of the sensory components of the spinal roots, small-diameter sensory nerves, and the sensory innervation of the spine via sinuvertebral nerve. Therefore, if the motor unit is anatomically and physiologically intact, the procedure is of little value in the diagnosis of MSP. Likewise, peripheral nerve conduction study is likely to be normal unless clear neurologic deficits are present. The present study illustrates that a good history and meticulous neurologic examination should be an integral part of an ideal electrodiagnostic procedure.

Key Words: Electromyography, musculoskeletal pain, neck and back pain

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INTRODUCTION

Needle electromyography (EMG) is a well-established procedure used frequently to diagnose conditions presenting with pain and various sensory symptoms in the spine and extremities and to explain the etiology of focal or diffuse muscle weakness. It is usually performed in conjunction with peripheral nerve conduction studies to diagnose entrapment neuropathies or polyneuropathies. Musculoskeletal pain (MSP), defined as local pain and tenderness in the soft tissues, spine, and joints, is a common symptom that brings patients to EMG laboratory for evaluation. In general, depending on clinical symptomatology, emphasis is focused on EMG to diagnose radiculopathy, plexopathy and myopathy, or on a peripheral nerve conduction study to diagnose peripheral neuropathy. The usefulness of EMG in MSP with the normal clinical neuromuscular examination and without clearly defined sensory deficits is re-assessed in this communication. The impetus that led to this retrospective study stemmed from an inordinate number of normal EMG studies in uncomplicated MSP elicited by the author in the past several years.

MATERIALS AND METHODS

Records of 75 patients ages 30–60 (45 males and 30 females) who underwent EMG and peripheral nerve conduction study in the past 7 years, were reviewed. They were selected from a group of 200 patients who were referred by their primary care providers and surgical specialists for evaluation of MSP in the neck, lower back, and extremities [Table 1]. All procedures were performed by the author, a board-certified neurologist and a board-certified electromyographer with 42 years and 36 years of practice experience for each specialty, respectively. None of the 75 patients selected had a history of diabetes, previous surgeries to the cervical and lumbar spine, systemic disorders, malignancy, connective tissue disorders, and muscle disease; hence, the reasons for their selection. The remaining 125 patients with various MSP were excluded due to various concurrent medical disorders and local pain and tenderness that affected more than one extremity. Their peripheral electrodiagnostic studies showed abnormalities that could be attributed from these disorders and previous spinal nerve root injuries in the cervical and lumbar spine. These abnormalities were related to various peripheral neuropathies, cervical and lumbosacral radiculopathies, and myopathies.

Of the 75, presenting symptoms were low back and neck pain (20 and 15 patients, respectively) associated with no-anatomical or nondermatomal paresthesias without sensory loss or focal muscle weakness in the affected extremity; and unilateral local pain and tenderness in

Table 1: Summary of patient profiles

	Number of patients
Total number surveyed	200
Number excluded*	125
Number included	75
Location of MSP and MRI findings	
Low back	20 (bulging and degenerating discs, osteoarthritis, facet hypertrophy, spinal stenosis, and spondylolisthesis [6 had herniated discs at L2-L3, L3-L4, L4-L5, and L5-S1])
Neck	15 (bulging discs and osteoarthritis [4 had herniated discs at C4-C5, C5-C6, and C6-C7])
Shoulder	6 (rotator cuff tear)
Elbow	7 (lateral epicondylitis)
Wrist	10 (tendinitis and osteoarthritis)
Hip	5 (bursitis)
Knee	7 (torn meniscus and osteoarthritis)
Ankle	5 (tendinitis and osteoarthritis)
Results of neurologic examination, EMG and nerve conduction studies	All normal

*Excluded due to concurrent medical disorders and previous spinal root injuries and surgeries. MSP: Musculoskeletal pain, MRI: Magnetic resonance imaging, EMG: Electromyography

the joints and soft tissues in the shoulder (6), elbow (7), wrist (10), hip (5), knee (7), and ankle (5). All patients with low back and neck pain were either occupational or related to vehicular accidents. Those with regional MSP in either upper or lower extremity were of uncertain origin. All patients were examined clinically and electrophysiologically, at least 3 months after onset of the symptoms.

Monopolar needle electrodes were used in all patients. Abnormal EMG was defined as presence of signs of active denervation (sharp positive waves and fibrillation potentials) alongside excessive complex motor units. Presence of rare complex units, absence of active denervation, and full activation of motor units during maximal contraction in association with completely normal clinical neurologic examination, was not considered an abnormal study. Minimum of four muscles (deltoid, triceps, brachioradialis and first dorsal interosseous for the upper extremity and vastus medialis, biceps femoris, tibialis anterior, and medial gastrocnemius for the lower extremity) and maximum of six muscles, using five quadrant sampling as tolerated, were tested in the affected extremity. Paraspinal muscle sampling was also performed as tolerated or was avoided in patients with severe low back or neck pain and muscle spasm.

Peripheral nerve conduction studies were performed using the standard technique for percutaneous nerve

stimulation and recording with surface electrodes. H-reflex study along with either tibial or peroneal motor nerve and sural nerve conduction studies were performed for patients presenting with low back pain and with nonanatomical or nondermatomal paresthesias or cool sensation in the affected extremity. In the upper extremity, the median and ulnar motor and sensory nerve conduction studies were performed. Measurement of late responses via F-wave latency determination was not routinely performed since this technique can only assess the motor components of the neural axis. Moreover, elicitation of F-wave requires several supramaximal stimulation that can be quite unpleasant to patients already suffering from MSP.

Magnetic resonance imaging (MRI) studies ordered by the referring health care providers prior to EMG study were reviewed. MRI findings included degenerating and bulging discs, facet hypertrophy, osteoarthritis, spinal stenosis, spondylolisthesis, rotator cuff tear, lateral epicondylitis, tendinitis, bursitis, and torn meniscus. Ten patients had herniated discs in various levels, four in the cervical (C4–C5, C5–C6, and C6–C7) and six in the lumbar (L3–L4, L4–L5, and L5–S1) spine.

RESULTS

None of the muscles sampled in all 75 patients, including 10 patients with cervical and lumbar herniated discs, showed EMG abnormalities. Clinically, those patients with herniated discs had normal muscle stretch reflexes and normal muscle tone and power. They had no sensory loss, fasciculations, or muscle atrophies. Low back pain that intensified with prolonged sitting or standing along with a limited range of motion correlated with the presence of either degenerating or bulging discs in the lumbar spine. None of the patients with various MRI findings in the cervical and lumbar spine and extremities had an abnormal neurologic examination. Local pain and tenderness in various parts of the affected extremities, some with swelling and limited range of motion of the affected joints, were not associated with neuromuscular deficits or signs of complex regional pain syndrome. Their EMG and peripheral nerve conduction study were normal.

DISCUSSION

Anatomically, a motor unit consists of anterior horn cell and its axon along with muscle fibers innervated by the terminal branches of this axon. Any lesion affecting any segment of the motor unit proximally and distally, will generate abnormal action potentials in EMG along with clinical motor deficits affecting specific myotomes or muscles innervated by a peripheral nerve.^[4] These abnormalities reflect dysfunction of the motor unit but

not of the sensory axis of the neuromuscular system. This is the essence of EMG, a diagnostic procedure that can only assess the components of the motor unit. It does not provide direct information about the peripheral sensory system but, nevertheless, still useful in the diagnosis of various symptoms related to dysfunction of the peripheral nervous system. Peripheral nerve conduction study, however, can provide information on the integrity of the peripheral sensory nerves but not of the sensory nerve roots or small-diameter sensory nerve fibers.

Of relevance in this discussion is the utility of EMG in MSP regardless of location. MSP may be accompanied by vague paresthesias without clear anatomical distribution in the affected limb and is frequently the presenting symptoms in musculoskeletal stress injuries in the workplace. Unless associated with focal muscle weakness or atrophy, EMG in these situations will likely yield negative results. The reason is obvious. MSP is the result of irritation of small-diameter A-delta and C-fiber sensory nerves.^[1,3] In the lumbar spine, the recurrent branch of the spinal nerve root, known as sinuvertebral nerve or recurrent nerve of Luschka, is particularly important because this nerve innervates the annulus fibrosus, ligaments, and periosteum of the spinal canal.^[2,5,6,7] Physiologically, irritation of the sinuvertebral nerve due to bulging or degenerating disc can not only generate local pain and tenderness in the spine but also generate “radicular” symptoms and cool sensation in the affected extremity. Such symptoms are likely related to the sensory impulse that may reverberate to the spinal nerve root where the sinuvertebral nerve originates and interconnects with the paravertebral sympathetic trunk. This phenomenology will explain the negative EMG in some cases of “radiculopathies” with the normal neuromuscular examination.

Presence of a herniated disc (or other abnormalities in the vertebra) does not necessarily lead to abnormal neurologic examination or EMG abnormalities, in fact, 10 of the patients studied showed otherwise. All these patients had no radicular symptoms, but had prominent MSP that were indicative of axial or mechanical injury rather than injury to the spinal nerve root as evidenced by normal clinical and EMG examination. Even in situations when a herniated disc is associated with sensory and motor deficits in the affected extremity, axial pain, and MSP remain the more prominent and disabling symptoms in most patients with back or neck injury thereby underscoring the pathophysiologic relevance of the sinuvertebral nerve in the generation of back pain. An abnormal EMG in those with motor deficits would only reflect the effect of spinal nerve root impingement by the herniated disc, but not the pain related to irritation of the sinuvertebral nerve, a pure sensory nerve.

EMG, in general, can be a painful and uncomfortable procedure. Some purists will go as far as sampling the

paraspinal muscles despite the presence of severe back pain and spasm in pursuit of EMG diagnosis. Multiple muscles, and, therefore, multiple needle punctures, are frequently sampled in an effort to elicit an abnormality. Others will rely on clinical examination and limit muscle sampling to a minimum. When the clinical history and clinical examination are diagnostic of a radiculopathy or focal neuropathy and corroborated by an imaging study, some practitioners find EMG unnecessary.

The presence of EMG “abnormalities” in cases of uncomplicated MSP with normal neurologic examination can lead to diagnostic and therapeutic obfuscation. They may also lead to inappropriate medicolegal claims following trauma to the musculoskeletal system. Thus, any EMG report must be interpreted in conjunction with the clinical history and examination and awareness of the limitations of this procedure.

Cost of an EMG procedure is worthy of consideration. Expense for a comprehensive procedure with peripheral nerve conduction study may range from \$400 to \$800. Thus, misuse of this procedure is a threat to health care cost. However, there are obvious situations when the cost is justified by a comprehensive procedure. This can occur when local MSP is complicated by concurrent medical or neuromuscular disorder, symptoms of which, some patients may not be aware of. A good neurological history and examination, however, can easily detect such occurrence. On the other hand, an unwary electromyographer can only make the situation confusing to the referring health care provider when reporting an abnormal EMG study.

There are important and intriguing questions that are worthy of serious considerations. Does a clinician-electromyographer have an obligation to proceed and perform the procedure knowing that the diagnosis is already obvious clinically and radiologically, and that the results are likely to be normal? Is it necessary to sample multiple muscles in the affected extremity or perform peripheral nerve conduction study if the presenting symptom is a localized MSP without sensory and motor

deficits? If the diagnosis or radiculopathy is already obvious, is it necessary to sample the very tender and tense paraspinal muscles simply to localize the lesion electrophysiologically at the expense of patient’s comfort? Multiple factors such as differences in medical judgment and referring physician’s approach to health care, medicolegal issues, and clinician-electromyographer’s training and diagnostic orientation, can only generate more questions whose answers are complex and controversial.

The results of this study should behoove any clinicians and surgeons to realize that needle EMG cannot assess sensory symptoms – particularly pain – directly; and that this procedure can only assess the components of the peripheral motor system. On the other hand, a negative study can still be diagnostically helpful and reassuring, thus, providing the referring health care providers valuable guide to the treatment of MSP. It is also equally helpful to know that an abnormal EMG and/or abnormal peripheral nerve conduction study can co-exist with MSP thereby providing incontrovertible evidence of peripheral neural process, symptoms of which can be masked by severe musculoskeletal symptoms, particularly MSP.

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