



PALMETTO HEALTH • Vol. 2 Issue 2 Spring 2016

# Neuroscience Journal

Band-Aid<sup>®</sup>  
surgery – what  
really happens  
below the  
incision  
pg. 5

EMG and nerve  
conduction studies in  
clinical practice  
pg. 9

# As physician co-leaders of Palmetto Health's neuroscience service,

we share a vision to provide the most advanced neurology and neurological surgery treatments available to the residents of South Carolina. We are excited to share this edition of our neuroscience journal featuring articles about minimally invasive surgery, how a drug has proved to be a powerful prevention of stroke, and the usefulness of electromyogram and nerve conduction studies in clinical practice.



**Souvik Sen, MD, MS, MPH**  
Chair of Neurology,  
Palmetto Health-USC Medical Group Neurology  
Professor of Neurology,  
University of South Carolina School of Medicine

**Roham Moftakhar, MD**  
Chief of Neurosurgery,  
Palmetto Health Richland  
Medical Director,  
Palmetto Health-USC Medical Group Neurosurgery  
Associate Professor of Clinical Surgery,  
University of South Carolina School of Medicine

# Study finds drug to be powerful tool in stroke prevention



**Souvik Sen, MD, MS, MPH**

**Chair of Neurology, Palmetto Health-USC Medical Group Neurology  
Professor of Neurology, University of South Carolina School of Medicine**

In a study published recently in the *New England Journal of Medicine*, research showed that pioglitazone (a drug within the class of thiazolidinediones) reduced the risk of stroke or heart attack by almost a quarter in patients who had previously suffered a stroke or mini-stroke.

While the effectiveness of blood thinners, statins and blood pressure management – the standards for post-stroke care – had been formerly demonstrated through evidence-based studies, the researchers wanted to look at a particular factor more carefully: insulin resistance.

Insulin resistance (or pre-diabetes) is famously associated with high risk of stroke or heart attack. Pitting pioglitazone against a placebo in a five-year, double-blind trial, the researchers found that patients receiving pioglitazone had 24 percent fewer incidences of either stroke or heart attack.

According to Souvik Sen, MD, Chair of Neurology at Palmetto Health-USC Medical Group Neurology and co-author of the study: "It's a very positive result; and it also represents a new approach toward better understanding an ailment that disproportionately strikes and kills in the Southeast for reasons that are not fully accounted for."

To read the complete study, go to [nejm.org/doi/10.1056/NEJMoa1506930](https://doi.org/10.1056/NEJMoa1506930).



# Band-Aid<sup>®</sup> surgery— what really happens below the incision

by Seth S. Molloy, DO, MSc  
Director of Spine Surgery, Palmetto Health-USC Medical Group Neurosurgery  
Assistant Professor of Clinical Surgery, University of South Carolina School of Medicine

**The commercials are alluring – the thought of a small incision, minimal postoperative pain and recovery.** Patients justifiably desire the most minimally invasive surgery (MIS) possible. Sure, it would be great if anyone with any spine issue can have a small incision and go home the same or next day; but, as with any contemporary treatment modality, we must apply and adapt the technology to the disease and not vice versa. This article will explore concepts behind MIS surgery, patient selection, what exactly happens below the incision, as well as expected recovery time frames.

## **MIS surgery – definition**

The MIS philosophy can simply be stated as when a surgeon achieves the goal to provide maximal operative or clinical benefit through the smallest operative window. However, MIS surgery is much more than the size of the incision; specifically when treating spines, it is how the tissues below the fascia are handled in an effort to maintain as much normalcy of the muscle and skeletal relationships so that the body can heal and function more naturally after surgical intervention. Goals are typically to prevent disruption and devitalization of muscle tissue and excessive removal of the underlying bone anchors surfaces or functional joints, such as lamina and facet joints, so that the spine can maintain healthy structure and function. With this in mind, we can decompress strategic areas with small dilating retractor tubes, insert hardware through much smaller paramedian incisions, and even use small incisions to insert our intervertebral cages. We now have the ability to apply these principles to a vast

array of pathology extending from degenerative disc disease to advanced scoliosis, trauma and even infectious and oncological cases.

## **Candidacy for MIS surgery**

Who would be an ideal candidate for MIS surgery? As my medical school statistics professor would always answer nearly any question, “it depends.” The core principles mentioned above can be applied across a broad range of patients with similar pathology. For degenerative cases, such as herniated discs and spinal stenosis, tubular retraction for decompression has succeeded in patients ranging from 16-year-old star athletes to octogenarians stricken with severe osteoporosis or even advanced rotatory scoliosis. We are now adapting percutaneous screw fixation in combination with MIS lateral intervertebral graft approaches from the side of the stomach to help us correct scoliosis. Similarly, for trauma cases, we are applying percutaneous screw insertion and rods with subsequent distraction or compression to correct major traumatic deformities that traditionally required large midline incisions (Figures 1 and 2). We have expanded use of these techniques more recently to cases such as epidural abscesses with promising results (Figure 3).

## **Technical aspects of surgery**

In a typical degenerative disc case when treating a disc herniation, we make a small incision ranging from 8 mm (for endoscopic approaches) to 18 mm so we can introduce a series of dilators in between the muscle fibers of one side of the spinous process and dock a cylindrical tube retractor in the interlaminar region. We introduce the tube in an oblique fashion from the

skin incision to dock onto the lamina in a way to avoid damaging the multifidus muscle, a key stabilizer of the spine that typically gets cauterized off the lamina along with the majority set of paraspinal muscle. Proponents of MIS surgery believe that preservation of this small postural muscle will prevent that functional vertebral segment from destabilizing postoperatively. Once the microscope is introduced we proceed with minimal lamina and facet drilling to expose and split the ligamentum flavum to allow us access to the epidural space where we then gently retract the traversing nerve root and remove the herniated disc fragment. We leave as much native tissue as possible, such as vascularized epidural adipose, in order to avoid the dreaded development of scar tissue – which can happen with standard approaches where larger amounts of tissue is removed to access the pathology. We even have applied advanced irrigating cautery devices to shrink disc bulging without charring the disc as typically seen with more traditional cautery devices. This provides indirect decompression of the spinal canal and exiting foramen to free nerves from residual compression.

We are extending MIS principles to trauma patients by introducing pedicle screws through similar muscle splitting technique versus moving all muscle off the spine. This has led to a significant decrease in blood loss, operative time and, best of all, recovery time for patients who are recovering from multiple injuries.

For infections and tumors, we can introduce retractors in the same fashion as noted above and can remove epidural infections and even intradural tumors with similar benefits.

**Recovery**

Typically, we expect clinical recovery for muscle and tissues (and even discs) to take anywhere from four to six weeks, on average. Most patients undergoing simpler degenerative disc surgery can return to driving and most non-strenuous activities within a week. Walking, or even light/cautious exercise right after surgery, is encouraged.

**Who is not a good candidate?**

Someone who has had multiple previous back surgeries can be difficult to treat regardless of techniques and generally requires a more traditional open technique of dissection to adequately address pathology. Even patients with severe spinal stenosis from facet enlargement may be better treated with

a more open technique since it is better to treat all of the pathology than have a small incision in these extremely diseased cases. The good news is that these patients still can qualify for less invasive or “mini-open” techniques which, to put it simply, is a strategic blend of MIS and traditional surgery. One example is reflecting muscle only on one side of the spine versus both, but allowing for much better visualization of the spine during the operation.

**In conclusion**

MIS surgery is an effective approach to spine pathology but does require proper application as with any surgical intervention. Promising benefits include minimal tissue dissection and scar development, reduced blood loss, less postoperative pain, shortened recovery and shortened length of stay. ◀

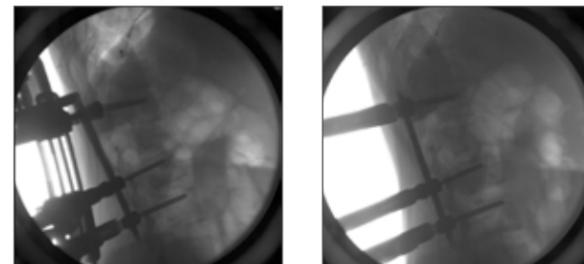


FIGURE 1 | Intraoperative photos demonstrating restoration/reduction of burst fracture using percutaneous technique.

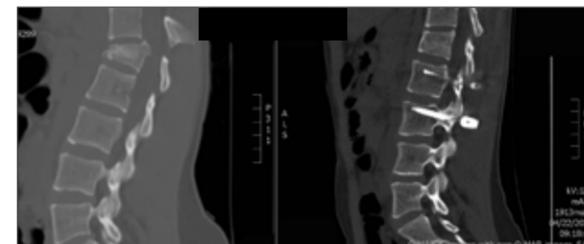


FIGURE 2 | CT showing traumatic L1 Burst fracture with retropulsion into the spinal canal in a 16-year-old with osteogenesis imperfecta (left). Note restoration of fracture vertebrae, sagittal balance and absorption of fragment in canal at three-month follow-up (right).

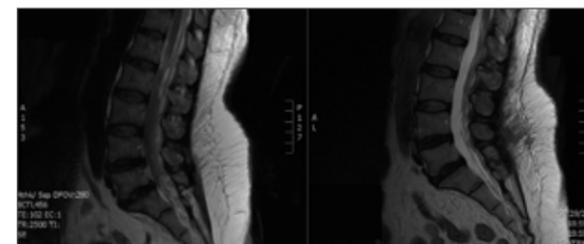


FIGURE 3 | Large Epidural Abscess expanding from T11 to S1 evacuated using less invasive surgical technique (left). Note preservation of spinous processes and surrounding supportive tissues (right).

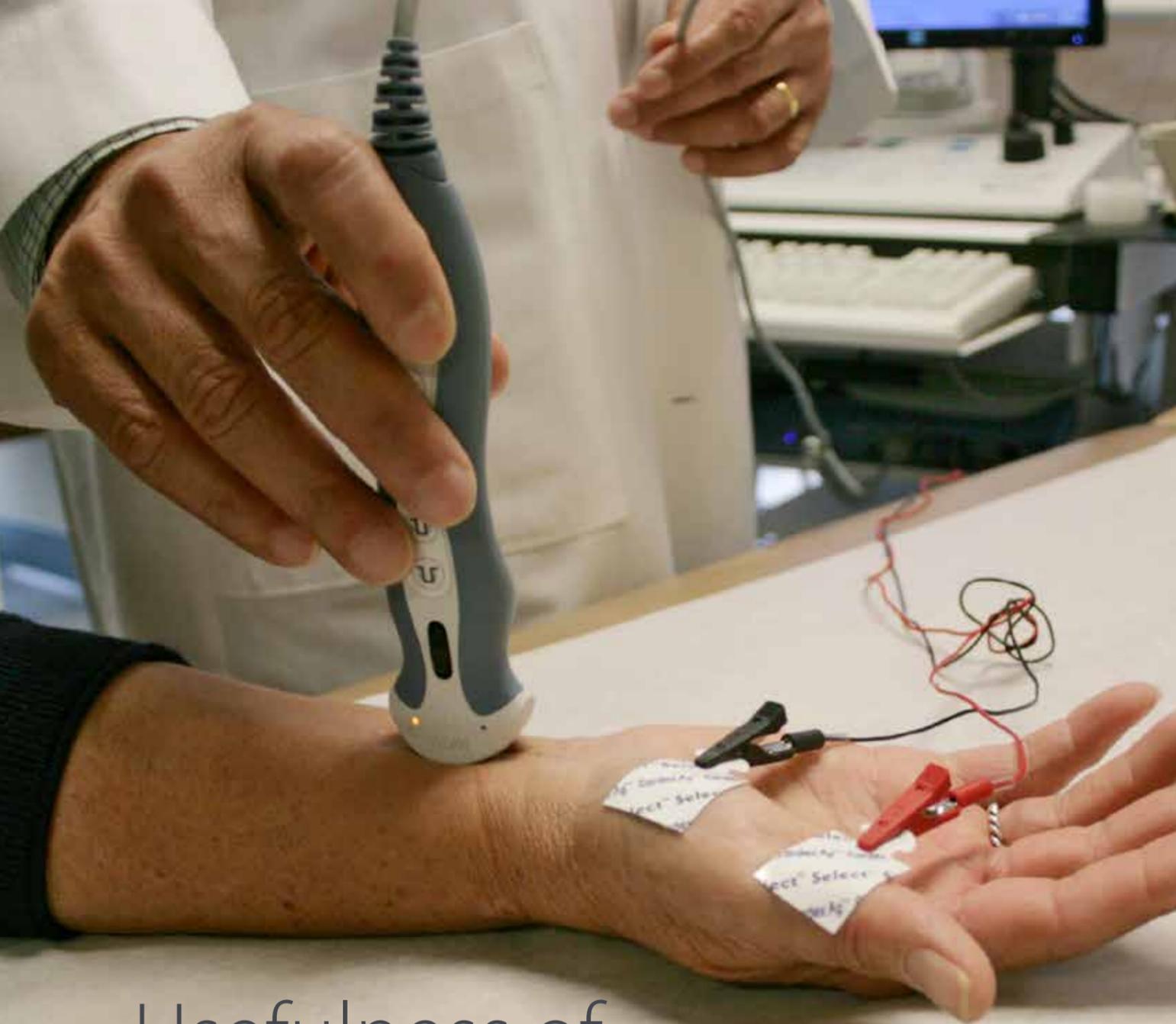
Palmetto Health's "4-BRAIN" phone line for neurosurgical transfers—*Because seconds matter.*

Providers now can call 844-64-BRAIN to transfer urgent and emergent neurosurgical and neurological patients easily and efficiently.

Studies have shown that one of the challenges faced by emergency room providers and referring physicians is fast and efficient access to neurological and neurosurgical physicians in tertiary medical centers. Palmetto Health's 4-BRAIN line allows emergency room providers and referring physicians to speak directly with a neurosurgeon or neurologist without going through an operator or long waits on the phone. Neurological problems that the 4-BRAIN line may be used for include intracerebral hemorrhages, subarachnoid hemorrhage, aneurysms, vascular malformations and brain tumors. The 4-BRAIN line is answered 24 hours a day, seven days a week.

Call 844-64-BRAIN (27246) for emergent neurosurgical transfers.





# Usefulness of electromyogram and nerve conduction studies in clinical practice

by Yedatore Swamy Venkatesh, MD, DM, FRCP (Edin), FAAN, FACP  
Program Director, Palmetto Health-USC Medical Group Neurology  
Professor of Neurology, University of South Carolina School of Medicine

Electrodiagnostic studies, commonly referred to as EMG studies, are helpful in evaluating symptoms predominantly of the anterior horn cell, root, plexus, nerve, neuromuscular junction and muscle. Limited evaluation of the upper motor neuron also is possible. Common referring symptoms include weakness, fatigue, muscle wasting, and sensory symptoms such as tingling and numbness.

The use of nerve conduction studies (NCS) owes much to the work of Galvani, Francois Magendie, Guillaume Duchenne and Carlo Matteucci, to mention a few. Herman von Helmholtz measured nerve conduction velocities in human subjects. Weddell, Hodes, Dawson and Scott refined it further in the 1940s.

## **The test**

Routine NCS includes studies of the motor and sensory fibers of the median, ulnar and radial nerves in the upper extremities and the motor fibers of the peroneal and tibial, and the sensory fibers of the superficial peroneal and sural nerves in the lower extremities; however, any accessible nerve in the body can be studied. Parameters routinely measured include the latency, amplitude and conduction velocity. Additionally, area and temporal dispersion also are assessed, depending on the clinical question asked. Late responses (H-reflexes and F-waves) provide information about the proximal segment.

Needle EMG is performed by inserting a needle electrode into the muscle of interest. The muscle is evaluated at rest and during varying levels of voluntary activation. Amplitude, duration, phases and recruitment patterns are assessed. Repetitive nerve stimulation (RNS) and single-fiber EMG (SFEMG) are utilized to look at disorders of the neuromuscular junction.

## **Value and utility of EMG**

EMG and NCS play a very important role in the evaluation of patients presenting with neuromuscular

problems when used as an extension of a neurological history and examination, helping to guide further testing and management. The study needs to be individualized depending on the presentation.

*Localization within the neuromuscular system.* EMG is extremely useful to localize the problem to a single nerve (mononeuropathy), several nerves (multifocal neuropathy or polyneuropathy), one or more nerve roots (radiculopathy or polyradiculopathy), plexus (plexopathy), anterior horn cell (motor neuronopathy) or dorsal root ganglion cell (sensory neuronopathy) muscle (myopathy) or neuromuscular junction. They are especially useful when exact localization is clinically difficult to determine.

*Fiber type involvement.* EMG and NCS gives insight on the affected fiber types, motor, sensory or both. It is, however, limited in that only the large diameter fibers are studied. Even though techniques such as near nerve studies are available to study smaller diameter fibers, they are technically difficult and painful and are not routinely used.

*Underlying pathophysiology.* EMG and NCS can determine the type of abnormality, demyelination or axonal loss or both. Features pointing to demyelination increased distal latency, slowing of the CV, conduction block and increased temporal dispersion. Acquired and hereditary etiologies can be distinguished.

Axonal loss causes reduction of the SNAP and CMAP amplitudes, the severity of which depends on the extent of the axonal damage. Mild slowing of the conduction velocities (CV) also occurs because of secondary demyelination, but not to the extent seen in the demyelinating cases. Both demyelinating and axonal loss lesions on needle examination show decreased recruitment. Fibrillation potentials and positive waves within one to three weeks is dependent on the distance between the site of the lesion and the muscle studied. Sequential appearance of fibrillations and PSWs can help date the injury. Features of reinnervation, such as large MUAPs with high amplitude and increased duration, may take several months. Absence of reinnervation after several months usually indicates a poor prognosis.

#### **Severity of the disease and prognosis for recovery**

EMG studies also can measure the severity and prognosis for recovery of the following:

*Traumatic nerve injury.* EMG provides valuable information about prognosis by characterizing the type of injury in traumatic nerve injury. Neuropraxia presents with conduction failure without axonal degeneration and has the best prognosis. Axonotmesis and neurotmesis affect the axon and carries poorer prognosis. Needle EMG also detects denervation of muscles that do not seem to be clinically affected and helps determine the true extent of the injury. It also may show residual innervation to paralyzed muscles and help determine surgical decisions. The optimal time to search for denervation changes is 10-to-14 days after the injury. Follow-up EMG studies may demonstrate reinnervation. Sensory studies are less helpful in evaluating axonal regeneration. Traumatic root avulsion and brachial plexopathy could be differentiated using EMG. Normal SNAPs in the presence of dermatomal sensory findings and denervation in myotomal distribution is the strongest evidence that favors root avulsion. It carries with it a dismal prognosis.

*Facial neuropathy.* EMG can estimate the severity and prognosis of patients with facial neuropathy. CMAP amplitude compared to the contralateral side is the best parameter, but there is no reliable technique to

evaluate patients in the first 24-48 hours. The optimal time for EMG study is at least five-to-eight days after onset. Detecting MUAPs in a paralyzed muscle is consistent with better prognosis.

*Radiculopathy.* EMG and NCS have less sensitivity when compared to radiologic studies particularly when only sensory symptoms are present. They may, however, help determine the level of involvement when multiple levels are affected on radiologic studies and help look for associated conditions. They are of little prognostic value in radiculopathy.

*Mononeuropathy.* Focal neuropathies such as carpal tunnel syndrome (CTS), ulnar neuropathy and peroneal neuropathy are precisely evaluated with NCS and the severity can be graded which aids in determining the need for surgery.

*Neuropathy.* Studies have shown a role in evaluating the response to therapy in diabetic polyneuropathy. In acute inflammatory demyelinating polyneuropathy or AIDP (GBS), axonal damage usually in the form of decreased distal CMAP amplitude of the peroneal, tibial, median and ulnar nerves has been found to be the most powerful predictor for prognosis. The degree of axonal damage determines the prognosis.

*Neuromuscular junction disorders.* SFEMG abnormalities show very good correlation with muscle strength in patients with myasthenia gravis (MG). A normal SFEMG study in a weak muscle is against a diagnosis of myasthenia gravis. It can be abnormal in patients with no clinical weakness. RNS is much less sensitive than SFEMG. Abnormal SFEMG is more likely in generalized than in ocular MG. EMG has value in diagnosis and management of patients with Lambert Eaton myasthenic syndrome (LEMS) and botulism. A low CMAP amplitude is generally seen followed by increment after exercise or high rates of stimulation and decrement at low-rate RNS.

*Muscle disease.* Small, brief and polyphasic motor units, as well as fibrillation potentials, and positive waves are frequently seen in patients with inflammatory myopathies. The presence or absence of spontaneous activity can be used as a marker

of response to treatment. Fibrillation potentials and positive waves are found in other myopathies associated with muscle fiber necrosis. In patients with inflammatory myopathies, the abnormal EMG also helps in picking a muscle biopsy site. Ideally, a muscle that is moderately affected should be biopsied. EMG is typically normal in steroid myopathy.

*Motor neuron disease.* EMG contributes to the identification of the lower motor neuron involvement in amyotrophic lateral sclerosis (ALS), with the presence of both active denervation and reinnervation. Findings may be found in asymptomatic regions. Presence of fasciculations is frequent but is not specific for ALS. For definite diagnosis at least three levels of the neuraxis (bulbar, cervical, thoracic, lumbar, sacral) need to be involved. ALS patients have normal sensory studies unless there is an underlying problem. Motor unit number estimation (MUNE) has value in following the disease progression, but is time consuming and is not routinely used.

#### **EMG in the ICU**

EMG studies are extremely useful in evaluating "difficult to wean" patients for the presence of GBS, critical illness neuropathy or myopathy, neuromuscular junction disorders and anterior horn cell disease. It is helpful in evaluating the function of the diaphragm with phrenic nerve studies and diaphragmatic EMG.

#### **Evaluation of sphincter function**

Needle EMG plays an important role in evaluation of the function of the urinary and anal sphincters and is used in conjunction with urodynamic studies to guide prognosis and treatment.

#### **Use in guided Botox injections**

Needle EMG is extremely useful in performing guided Botox® injections, especially in muscles where precise localization and dosage needs to be achieved.

#### **Temporal Course of Disease**

EMG studies provide information on the temporal course of the disease and help classify it into hyperacute (one week), acute (a few weeks), subacute (a few weeks to a few months) or chronic (months to years).

#### **Limitations**

EMG studies are normal in patients with small fiber peripheral neuropathy who present with burning pain and hypersensitivity. The study may not be revealing in some types of myopathy like steroid myopathy and congenital myopathies. The study may be negative if done very early before Wallerian degeneration has developed and should be repeated if needed.

#### **Conclusions**

EMG studies are valuable in patients with neuromuscular disorders and, ideally, are used as an extension of the clinical examination. They are tailored for each individual patient. Important information regarding localization, underlying pathophysiology, severity, temporal course and prognosis can be obtained. The test has some limitations as outlined above. ◀

Abbreviation key:  
EMG study collectively refers to both nerve conduction studies and needle electromyography  
CMAP: Compound muscle action potential  
SNAP: Sensory nerve action potential  
MUAP: Motor unit action potential  
SFEMG: Single fiber EMG  
MUNE: Motor unit number estimate  
PSWs: Positive sharp waves  
randomized, sham-controlled study." Cephalalgia. 2013 Jul;33(10):816-30.



PO Box 2266  
Columbia, SC 29202-2266

PRSRT STD  
U.S. POSTAGE  
PAID  
COLUMBIA, S.C.  
PERMIT NO. 740

PRODUCED BY MARKETING AND COMMUNICATIONS © 2016 PALMETTO HEALTH  
5/16 MC-10040

## Contact us for more information or to refer a patient

### Palmetto Health-USC Medical Group Neurosurgery

3 Richland Medical Park Dr., Suite 310, Columbia, SC 29203  
9 Richland Medical Park Dr., Suite 640, Columbia, SC 29203 (pediatric office)  
300 Palmetto Health Pkwy., Suite 200, Columbia, SC 29212  
Phone: 803-434-8323  
Fax: 803-434-8326  
[PalmettoHealth.org/PHNeurosurgery](http://PalmettoHealth.org/PHNeurosurgery)

### Palmetto Health-USC Medical Group Neurology

8 Richland Medical Park Dr., Suite 420, Columbia, SC 29203  
Phone: 803-545-6050  
Fax: 803-545-6051  
[neurology.med.sc.edu](http://neurology.med.sc.edu)

**Call 844-64-BRAIN (27246) for emergent neurosurgical transfers.**



Care to be remembered.

**PalmettoHealth.org 803-296-CARE (2273)**

**Our Vision:** To be remembered by each patient as providing the care and compassion we want for our families and ourselves.