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Evaluating The Accuracy of Electrodiagnostic Study in Detecting Suprascapular Neuropathy in Cases of Chronic Shoulder Pain

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ABSTRACT
Background: Electrophysiological study involving electromyography (EMG) and nerve conduction studies are important tools for diagnosis of entrapment neuropathy, as it had a great role in determining the etiology, and severity of entrapment, confirming the diagnosis, detecting the site, quantifying the degree of compression as well as documenting the progression and prognosis of the disorder.
Objectives: To assess the accuracy of electrophysiological studies in diagnosing suprascapular neuropathy in cases of chronic shoulder pain.
Patients and Methods: A controlled randomized prospective study was carried out on 180 patients with chronic shoulder pain. They were recruited from outpatient clinics of rheumatology, physical medicine, and rehabilitation at our university. Electrophysiological study regarding nerve conduction study (NCS) of both suprascapular nerves and EMG study to the supraspinatus and infraspinatus muscles were carried out.
Results: Approximately 11.1% of patients of the current study were diagnosed as suprascapular neuropathy regarding abnormal motor nerve conduction study results, and 9.4% of patients were diagnosed based on abnormal electromyographic findings. The latency and amplitude of suprascapular nerve on motor nerve conductive (MNC) at cutoff value of >2.35, and <6.95 had accuracy of 69.1%, and 66.7% to detect the occurrence of suprascapular neuropathy. The duration, and amplitude of supraspinatus MUAP on EMG at cutoff value of >5.85, and <1.175 had an accuracy of 74.7%, and 74%, also, the duration, of infraspinatus MUAP on EMG at cutoff value of >6.1 had 79% accuracy, that means at those points, we could differentiate between the affected and non-affected suprascapular nerve.
Conclusion: Electrophysiological study involving electromyography (EMG), and nerve conduction studies is an important and accurate tool for diagnosing suprascapular neuropathy in cases of chronic shoulder pain, with accurate and precise cutoff points, in addition to clinical examination and radiological findings.
Keywords: Electromyography, Nerve conduction study, Suprascapular neuropathy.

INTRODUCTION
A disorder known as entrapment neuropathy occurs when a nerve becomes squeezed between two other bodily parts. The nerve is typically squeezed between a bone and a ligament. The ligament and bone may push or rub on the nerve as a result of repetitive motion. Numbness, tingling, burning, or muscular weakness are signs of demyelinating neuropathy, a condition that gradually weakens the myelin coating and reduces the nerve's capacity to send messages [(1)].

Electrodiagnostic tests, such as NCS in relation to sensory nerve conductive studies (SNCS), motor nerve conductive studies (MNCS), and needle EMG, can assist the diagnosis of entrapment neuropathy. Electrodiagnostic (EDX) testing can identify the cause and extent of entrapment, validate the diagnosis, identify the location, measure the level of compression, and record the disorder's course and outcome [(1)].

Suprascapular nerve arises from cervical roots 5, and 6 of brachial plexus. It provides the motor and sensory innervation to supra- and infraspinatus muscles in order to stabilize arm movements that occur at the shoulder joint. Suprascapular nerve entrapment is a condition that results from impingement or damage to the suprascapular nerve [(2)].

There are many places along the suprascapular nerve's course where entrapment might happen. Pain, weakness, and atrophy of the supraspinatus and infraspinatus muscles are the main symptoms. Given the increased number of diagnoses, this illness could be more widespread than previously believed [(3)].

Radiological evaluation of the cervical spine and shoulder joint is helpful in differentiating the disease from other clinical entities that appear similarly. While, the electrodiagnostic study (EMG) had a major role in confirming the diagnosis of neuropathy indicating its type, severity, and progression [(3,4)].

We aimed to assess the accuracy of electrophysiological studies in diagnosing suprascapular neuropathy in cases of chronic shoulder pain.

PATIENTS AND METHODS
This controlled randomized prospective study was carried out on 180 patients with chronic shoulder pain. They were recruited from rheumatology, physical medicine and rehabilitation outpatient clinics, Menoufia University hospitals during the period from December 2021 to November 2023.

The study included patients aged above 20 years of both sexes complaining of chronic shoulder pain for more than 6 weeks, with or without supraspinatus and infraspinatus muscle wasting.

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Clinical assessment:

All the patients were subjected to full history taking including personal history, patient complaint, pain characteristics as site, onset, course, duration, associated manifestations, precipitating factors, relieving factors, extent, radiation, severity and timing. The clinical examination was done included general (regarding pulse, temperature, respiratory rate, and blood pressure) and local examination of the shoulder regarding inspection overlying skin for scar, color changes, and for presence of deformities, wasting to supraspinatus, infraspinatus and swelling. Muscle power of supraspinatus and infraspinatus at both sides was assessed to detect the muscle weakness. Suprascapular stretch test was used to assess the integrity and flexibility of the suprascapular nerve.

All the participants were subjected to: Complete blood count (CBC), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), liver function tests, kidney function test, random blood sugar, anti-nuclear antibody (ANA), and rheumatoid factor (RF) were assessed**.**

X-rays on the shoulder joints to exclude any fracture or dislocation, and on cervical spine to exclude any cervical pathology that may cause referred pain to shoulder were done.

Electrophysiological study involving: Nerve conduction study of both suprascapular nerves was done to detect latency and amplitude at supraspinatus muscle at both sides. A comparison between the affected side and the healthy side was done.

Electromyographical study to the supraspinatus and infraspinatus muscle was also, carried out to detect the insertional activity (positive sharp waves or fibrillation potentials), spontaneous activity, motor unit action potential (duration, amplitude, phases) and interference pattern (complete and incomplete interference pattern.

Ethical approval:

Following a thorough description of the study, all the patients provided written and informed permission in accordance with Menoufia University's Faculty of Medicine's Ethics Committee, which approved the study. Throughout its implementation, the study complied with the Helsinki Declaration.

Statistical analysis

Statistical analysis, tabulation, and data collection were conducted using an IBM personal computer running SPSS version 20.0. Mean± SD and range were used to portray the quantitative data, whereas numbers and percentages were used to convey the qualitative data. The Student t-test was utilized to compare two groups using quantitative factors. In order to compare two groups with quantitative variables that are not normally distributed, we employed the Mann-Whitney test. The ROC curve provided the sensitivity and specificity. Any p-value that was equal to or less than 0.05 was regarded as significant.

RESULTS

A controlled randomized prospective study included 180 patients complaining of shoulder pain; their complain duration ranged from 11- 20 months with a mean duration of 11.18±9.52 months, their mean age was 43.23±8.23 years; 66.1% of the patients were males, laboratory parameters of the studied participants were within normal ranges regarding CBC (HB, Platelet, and WBC), ESR, SGOT, SGPT, S. creatinine **(Table 1)**.

Approximately 11.1% of patients in the current study were diagnosed as suprascapular neuropathy, regarding abnormal motor nerve conduction study findings, whereas; 9.4% of them were diagnosed based on abnormal EMG results. Among the 11.1% cases of suprascapular motor neuropathy, approximately 4.4% showed axonal neuropathy characterized by decreased amplitude, whereas 7.2% showed signs of demyelinating neuropathy with delayed latency **(Table 1)**.

Table (1): The demographic and laboratory data of the studied participants.

Participants of the study (n=180)	
Sex N (%) Female Male	 61(33.9%) 119(66.1%)
Age (years) Range Mean±SD	 35-51 43.23±8.23
Duration of complain (months) Range	11-20 11.18±9.52
Number of cases with abnormal MNCS Axonal neuropathy Demyelinating neuropathy	20(11.1%) 8(4.4%) 13(7.2%)
Number of cases with abnormal EMG	17(9.4%)
HB (g/dL)	12.63±1.56
PLT (x10^9/L)	278±68.9
WBC (mcL)	6.90±1.72
ESR (mm/hr)	26.39±6.3
SGOT	19±4.61
SGPT	19.55±4.81
S Creatinine (mg/dl)	0.916±0.22
RBS (mg/dL)	91.01±16.58

On comparing the EMG parameters of supra- and infraspinatus muscle among the affected and non-affected nerves, we recorded significant reduction of the MUAP amplitude and incomplete interference pattern of infra- and supraspinatus muscles among 24.4% of cases, with increased duration in the affected suprascapular nerve compared to the non-affected **(Table 2)**.

Table (2): Comparing the EMG parameters of supra- and infraspinatus muscle among the affected and the non-affected suprascapular nerve.

EMG	Affected limb Mean±SD	Sound limb Mean±SD	*p-value*
Supraspinatus			
Amplitude of MUAP	1.51±0.66	1.12±0.15	<0.0001
Duration	10.15±4.11	6.26±1.9	<0.0001
Phases	4.06±1.18	4.18±0.44	0.358
Interference pattern incomplete interference pattern complete	44 (24.4%) 136 (75.6%)	0 (0%) 180 (100%)	<0.0001
Infraspinatus			
Amplitude of MUAP	1.14±0.67	1.13±0.38	0.284
Duration	7.45±2.02	5.45±0.83	<0.0001
Phases	3.68±0.97	3.75±0.46	0.561
Interference pattern incomplete interference pattern complete	40 (22.2%) 140 (77.8%)	0 (0%) 180 (100%)	<0.0001

The discriminative power of the amplitude and duration of EMG in differentiating between the normal and affected suprascapular nerve revealed that the duration of motor unit action potential MUAP of supraspinatus muscle at cutoff value of >5.85, and amplitude at cutoff value of <1.175 had accuracy of 74.7%, and 74% respectively, while; the duration of motor unit action potential MUAP of infraspinatus at cutoff value of >6.1 had accuracy of 79%, that means at those points, we could differentiate between the affected and non-affected suprascapular nerve **(Table 3).**

Table (3): The discriminative power of the MUAP of supra- and infraspinatus in differentiating between the affected and sound nerve.

MNC	Cut-off	AROC	P-value	Sensitivity	Specificity	PPV	NPV	Accuracy
Supraspinatus duration	>5.85	0.703	<0.0001	67.8%	83.3%	83.6%	67.4%	74.7%
Supraspinatus Amplitude	>1.175	0.681	<0.0001	66.7%	83.3%	83.3%	66.7%	74%
Infraspinatus duration	>6.1	0.831	<0.0001	75.6%	83.3%	85%	73.2%	79%

By using the ROC curve; the discriminative power of the latency and amplitude of MNCS in differentiating between the normal and affected suprascapular nerve revealed that the latency of MNCS at cutoff value of >2.35 ms had 69.1% accuracy and the amplitude of MNCS at cutoff value of <6.95 had 66.7% accuracy (this means that suprascapular neuropathy should be diagnosed in cases of delayed latency above 2.35 ms, and/or decreased amplitude below 6.95) **(Figure 1).**

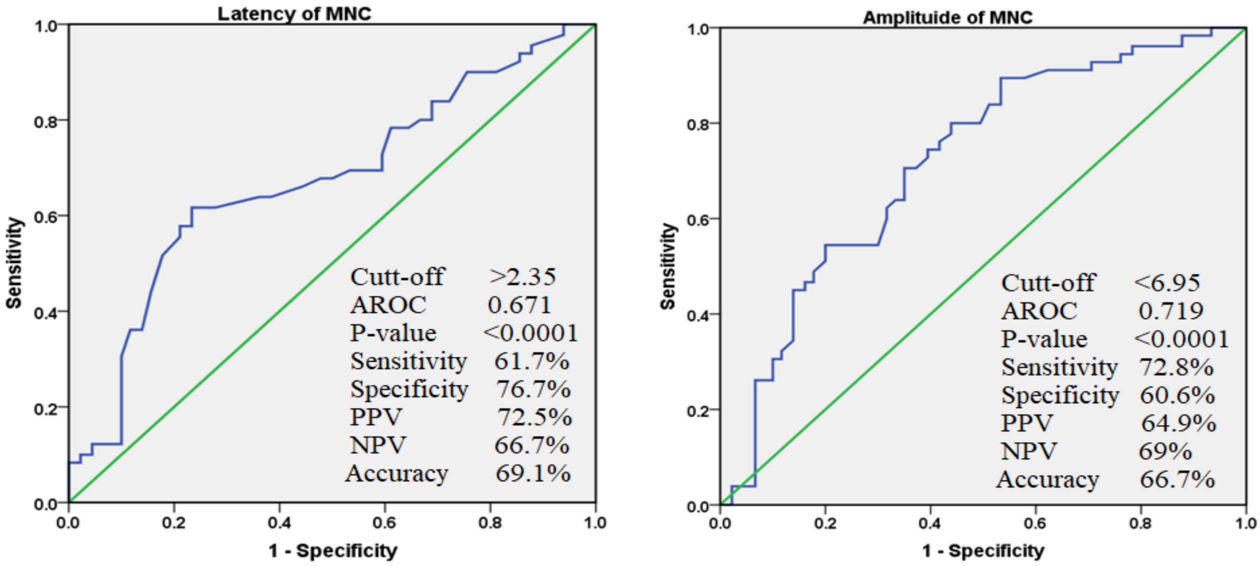

Figure (1): ROC curve showing the discriminative power of the latency and amplitude of MNC in differentiating between the normal and affected side.

DISCUSSION

A condition known as suprascapular nerve entrapment is defined by injury or compression of the suprascapular nerve. One diagnostic technique for evaluating the integrity and functionality of the suprascapular nerve is electrophysiological analysis. It is commonly performed to evaluate suprascapular neuropathy **(5)**.

We had conducted a controlled randomized prospective study on 180 patients with chronic shoulder pain that was persistent more than 6 weeks to assess the accuracy of electrophysiological studies in diagnosing suprascapular neuropathy in cases of chronic shoulder pain**.**

Concomitant with our results; **Park *et al.* (6)** and **Alattas *et al.* (7)** studies reported that males are more likely to suffer from suprascapular nerve entrapment than females. Also, in concomitance with or results **Brzoska *et al.* (8)** reported that suprascapular neuropathy primarily affected individuals younger than 40 years old.

In agreement with our findings **Leider *et al.* (9)**, also reported that the patients with suprascapular neuropathy often describe dull aching pain near spine of the scapula, paresthesia, and positive suprascapular stretch test.

Approximately 11.1% of patients in the current study were diagnosed as suprascapular neuropathy, regarding abnormal motor nerve conduction study findings, whereas; 9.4% of them were diagnosed based on abnormal EMG results. Among cases of suprascapular motor neuropathy diagnosed regarding MNCS, approximately 4.4% showed axonal neuropathy characterized by decreased amplitude, whereas 7.2% showed signs of demyelinating neuropathy with delayed latency.

Similarly, previous studies reported that suprascapular neuropathy was present in 4% of patients with shoulder pain, and these rates were higher in athletes, ranging from 12 to 33% **(10,11)**. However, a study conducted by **Boykin *et al.* (12),** reported that 42% of their patients were diagnosed with suprascapular neuropathy, out of them 33% were diagnosed based on NCS and EMG, while 9% were diagnosed with suprascapular nerve neuropathy regarding delayed latency in motor NCS without EMG abnormalities.

The present study reported the affection of the supraspinatus muscle only during electromyography study among patients who were diagnosed with suprascapular neuropathy. This finding differs from **Mallon *et al.* (13),** who reported the affection of both the supraspinatus and infraspinatus muscles based on electromyography findings.

Additionally, other studies by **Lajtai *et al.* (14),** and **Economides *et al.* (15),** suggested that affection was limited to the infraspinatus muscle in patients diagnosed with suprascapular nerve neuropathy.

We can attribute our findings regarding the involvement of the supraspinatus muscle exclusively to its superficial location, making it more susceptible to affection and easier to detect through electromyography.

The study reported the cutoff points for motor nerve conduction study from the parameters of the healthy unaffected shoulders, regarding amplitude, which was equal to or more than 6.95 millivolts, and latency that was equal to or less than 2.35 milliseconds, respectively, with 61.7%, sensitivity, and 76.7% specificity for latency and 72.8%, sensitivity, 60.6% specificity for amplitude.

Another study recorded the values of 2.58±0.46 milliseconds in latency and 12.6±2.7 millivolts in amplitude. These values were considered as a reference for suprascapular nerve parameters in relation to MNCS in that study **(16)**. Meanwhile, our reference values in our study were based on the reference values of participants' healthy shoulders.

The present study calculated the cutoff point of the supraspinatus muscle regarding electromyography motor unit action potential, which was at a duration 5.85 milliseconds and at amplitude of MUAP 1.175 millivolts. For the infraspinatus muscle, the cutoff point in electromyography duration was 6.1 milliseconds that had 67.8% sensitivity, and 83.3% specificity.

CONCLUSION

Electrophysiological study involving electromyography (EMG), and nerve conduction studies is an important accurate, tool for diagnosing suprascapular neuropathy in cases of shoulder pain, with precise, sensitive, and specific cutoff points, in addition to clinical examination, and radiological findings.

Conflicts of interest: None declared.
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