Musculocutaneous Neuropathy: Case Report and Discussion

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Abstract The musculocutaneous nerve arises from the lateral cord of the brachial plexus and contains fibers from the C5, C6, and C7 spinal nerve roots. It innervates such muscles as the biceps brachii and brachialis as well as supply branches to the skin over the lateral cubital and forearm regions via the lateral antebrachial cutaneous nerve. Musculocutaneous neuropathy can arise from exercise, participating in sports, strenuous activity, cast placement, trauma, and surgery in addition to other less understood causes such as Parsonage Turner syndrome. We present the case of a 55-year-old female who complained of numbness, weakness, and pain throughout the arm starting 1 day following a surgical procedure. Electrodiagnostic testing revealed a musculocutaneous neuropathy with significant axonal injury. Symptoms of musculocutaneous neuropathy may be similar to cervical spinal nerve root impingement or brachial plexus lesions. Therefore, magnetic resonance imaging and electrodiagnostic studies may be useful in differentiating between these conditions. Once the diagnosis of musculocutaneous neuropathy has been made, treatments include relative rest, nonsteroidal anti-inflammatory drugs,

splinting, physical therapy, and surgical decompression in cases that do not respond to conservative management.

Keywords musculocutaneous neuropathy · lateral antebrachial cutaneous nerve · LACN · Parsonage Turner Syndrome · electrodiagnostic testing

Case presentation

This 55-year-old female who presented with complaints of right shoulder pain was referred for musculoskeletal evaluation and electrodiagnostic testing. The patient reported that her right shoulder pain began 1 day after surgery involving an osteotomy performed on the right tibia to repair an equinus deformity of the right foot. The pain was noted predominately at the right shoulder girdle and radiated down the right arm to the thumb. She noted numbness, weakness, and pain throughout the right arm.

During the review of symptoms, the patient denied any neck pain, fever, chills, weight loss, night pain, heart problems, bowel or bladder incontinence, and morning stiffness. The physical examination noted full range of motion of the shoulder with flexion and abduction to 180° resulting in mild pain at the end of the range of motion. There was no atrophy or deformity of the right shoulder. Scapulothoracic motion was fluid and symmetric. Impingement tests of the right shoulder, including Hawkins' and Neer's tests, were negative. Full range of extension and flexion was present at the elbow. Full range of motion was also noted at the cervical spine with the exception of extension, which was limited to approximately 15° and reproduced some right arm discomfort. Manual muscle testing was 5/5 throughout the right and left upper extremities with the exception of 4/5 in the right biceps brachii and pronator teres. Sensation was diminished to light touch throughout the right C5 dermatome. A 1+ reflex was noted at the right biceps brachii tendon with 2+ at the left biceps brachii tendon and 2+ symmetrically at the bilateral triceps and brachioradialis tendons. Spurling's test did reproduce some discomfort along the right arm.

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Each author certifies that his or her institution has approved the reporting of this case, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Given the physical examination, further electrodiagnostic and radiological exams were warranted to evaluate the possible presence of a C5 radiculopathy versus a neuropathy. In addition, Lyrica was prescribed to aid in alleviating the patient's discomfort. A computed tomography (CT) scan was performed to evaluate for C5 and C6 radiculopathies with possible foraminal stenosis. The CT scan showed advanced degenerative disk space narrowing at C3–4 and C4–5 with slight retrolisthesis. During a follow-up visit, electromyography (EMG) and nerve conduction studies (NCS) were performed. The motor NCS showed a right median motor nerve onset of 2.8 ms at the wrist and a right ulnar segmental motor nerve onset of 2.8 ms at the wrist (Table 1). The sensory NCS showed a left lateral antebrachial cutaneous sensory nerve onset of 2.1 ms at the lateral forearm while the right lateral antebrachial cutaneous sensory nerve onset was nonreactive at the forearm (Table 2 and Fig. 1). In addition, the right median sensory nerve onset was 2.7 ms at the second digit; left superficial radial sensory nerve onset was 1.8 ms; right superficial radial sensory nerve onset was 1.8 ms, and right ulnar sensory nerve onset was 2.9 ms at the fifth digit (Table 3). Furthermore, 1+ fibrillations and 2+ positive sharp waves were present at the right biceps brachii as well as a decrease in the recruitment pattern and presence of nascents. Testing of the remainder of the upper extremity musculature and paraspinal muscles did not reveal additional spontaneous activity. MRI of the right brachial plexus did not reveal any abnormality consistent with a pathologic mass or other source of compression. We concluded that the electrodiagnostic testing of the upper extremities confirmed a right musculocutaneous neuropathy with more severe involvement of the LACN and significant axonal injury.

Discussion: musculocutaneous neuropathy

The musculocutaneous nerve arises from the lateral cord of the brachial plexus and contains fibers from the C5, C6, and C7 spinal nerve roots. However, the most important contributions come from the C5 and C6 levels [1, 2]. The musculocutaneous nerve passes through the coracobrachialis muscle and descends between the biceps brachii and brachialis muscles which it innervates [1]. The nerve emerges from between these muscles by the lateral margin

of the biceps aponeurosis as the LACN [3]. The LACN supplies cutaneous branches to the skin over the lateral cubital region before dividing into anterior and posterior terminal cutaneous branches innervating the skin of the lateral forearm [1]. Compression of the nerve proximally at the level of the coracobrachialis muscle manifests with pain and weakness of the biceps brachii and dysesthesia over the radial side of the forearm [2, 4].

Musculocutaneous neuropathy with weakness of the biceps brachii muscle and a sensory deficit in the distribution of the LACN has been reported in the literature following prolonged repetitive forceful contracture of the elbow flexors, such as following prolonged windsurfing with the right upper extremity slightly flexed at the elbow and with the hand gripped over the boom [5]. Typically, the pain can be reproduced with full extension at the elbow. Another instance of musculocutaneous nerve injury following exercise is reported in the literature in a 20-year-old male who presented with marked weakness of the biceps brachii the morning after a vigorous workout with weights [6]. His examination revealed an absent biceps tendon reflex, reduced biceps brachii muscle tone, and mild hypoesthesia on the radial aspect of the volar forearm. Musculocutaneous neuropathy is also described in the literature in a 37-year-old male presenting 5 weeks after moving large rolls of yarn [7]. The rolls were 65 to 80 lb in weight, and the patient curled his arm around the rolls he carried on his shoulder for stabilization. The following morning, he noticed an inability to flex his right elbow.

Compression may also be a cause for isolated musculocutaneous neuropathy as in a 22-year-old male who presented with painless biceps brachii weakness the morning after playing recreational basketball [8]. Over the following 9 days, the symptoms progressed to an inability to contract the biceps brachii and significantly reduced sensation together with intensifying paresthesia on the right volar forearm. A 2×2 cm exostosis was eventually identified impinging on the musculocutaneous nerve after its origin from the lateral cord. Compression of the LACN following placement of a long arm cast has also been reported in the literature in a 25-year-old male [9]. The patient experienced a painful dysesthesia on the radial aspect of the forearm within 3 days of casting that was not relieved by removing the cast. A fibrous constricting band was identified, and eventually, a surgical decompression was performed.

Table 1 Nerve conduction study: motor nerves

Site	NR	Onset (ms)	Norm onset (ms)	O-P amp (mV)	Norm O-P Amp	Site 1	Site 2	Delta-0 (ms)	Dist (cm)	Vel (m/s)	Norm vel (m/s)
Right median motor (abd pol brev) 30.4°C											
Wrist		2.8	<3.6	11.0	>4	Pron Ter	Wrist	4.2	26	61.9	>50
Pron Ter		7.0		10.6							
Right ulnar seg motor (abd dig minimi) 30.4°C											
Wrist		2.8	<3.6	8.8	>3	Abv FCU	Wrist	3.5	23.5	67.1	>50
Abv FCU		6.3		8.3		Abv Uln Grv	Abv FCU	2.1	13	61.9	>50
Abv Uln Grv		8.4		8.2							

Table 2 Nerve conduction study: sensory nerves

Site	NR	Onset (ms)	Norm onset (ms)	O-P amp (μ V)	Norm O-P amp	Site 1	Site 2	Delta-0 (ms)	Dist (cm)	Vel (m/s)	Norm vel (m/s)
Left lat antebrach cutan sensory (lat forearm)				29.9°C							
Elbow		2.1		15.0		Elbow	Lat forearm	2.1	12.0	57.1	
Right lat antebrach cutan sensory (lat forearm)				29.8°C							
Elbow	NR					Elbow	Lat forearm		0.0		
Right median D2 sensory (2nd digit)				30.1°C							
Wrist		2.7	<3.2	50.1	>10						
Left sup radial sensory (FWS)				30.1°C							
Forearm		1.8		29.2	>10	Forearm	FWS	1.8	11.0	61.1	>45
Right sup radial sensory (FWS)				29.4°C							
Forearm		1.8		25.8	>10	Forearm	FWS	1.8	12.0	66.7	>45
Right ulnar sensory (5th digit)				30.3°C							
Wrist		2.9	<3.2	37.3	>10	Wrist	5th digit	2.9	0.0		

Trauma may result in musculocutaneous nerve injury as well. For example, Liveson reported cases of such neuropathies resulting from shoulder injury [10]. Five out of 11 patients studied had injury to the musculocutaneous nerve. Three of these cases occurred following anterior shoulder subluxation and one following a humeral fracture with dislocation. No details were given regarding the injuries of the last patient. However, only one of these five patients had an isolated musculocutaneous nerve injury. Two of the patients also had axillary nerve damage (the axillary nerve being the most commonly injured in anterior shoulder dislocation). Another two patients had extensive brachial plexus damage. The author concluded that “the musculocutaneous nerve seems particularly vulnerable from shoulder dislocation.”

Inflammation secondary to osteoid osteomas may present with these symptoms as well. There is a report of a 5-year-old boy who presented with moderate weakness of the biceps brachii muscle without evidence of progression following 7 months of shoulder pain and functional

limitations [11]. A CT scan showed an osteoid osteoma at the base of the coracoid process with surrounding soft tissue inflammation.

An isolated musculocutaneous nerve injury has also been reported in the literature in a 21-year-old male following a 10-h surgical procedure in which both arms were positioned in external rotation and abduction at approximately 90° [12]. The surgical table was placed in the Trendelenburg position with the patient’s head approximately 2 in. below his feet. Fourteen days following surgery, the patient presented with tenderness at the left arm, and manual muscle strength testing revealed 3/5 at the left elbow flexors [12].

In addition to the above causes of musculocutaneous and LACN neuropathy, brachial neuritis, also known as Parsonage Turner syndrome, has been shown to result in similar nerve injuries. Parsonage Turner syndrome is a rare disorder of unknown etiology, usually presenting with pain and weakness of the shoulder and upper extremity [13]. It is one of the more common atraumatic causes of brachial plexopathy. Although

Fig. 1. Waveforms for the lateral antebrachial cutaneous sensory nerves comparing left (asymptomatic) and right (symptomatic) sides

Table 3 Electromyography

Side	Muscle	Nerve	Root	Ins act	Fibs	Psw	Fascic	Amp	Dur	Configuration	Rec pat	Rec int
Right	Abd poll brev	Median	C8–T1	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml
Right	1stDorInt	Ulnar	C8–T1	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml
Right	FlexCarRad	Median	C6–7	Nml	0	0	0	Nml	Nml	Di/Triphasic	Full	Nml
Right	Triceps (lat hd)	Radial	C6–7	Nml	0	0	0	Nml	Nml	Di/Triphasic	Full	Nml
Right	Biceps	Musculocut	C5–6	Nml	1+	2+	0	Nml	Long	Nascents	Dec	Nml
Right	Deltoid (mid)	Axillary	C5–6	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml
Right	Supraspinatus	SupraScap	C5–6	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml
Right	Infraspinatus	SupraScap	C5–6	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml
Right	Rhombooid	DorsalScap	C5	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml
Right	BrachioRad	Radial	C5–6	Nml	0	0	0	Nml	Nml	Di/triphasic	Full	Nml

brachial neuritis was first described as such by Parsonage and Turner in 1948 [14, 15], reports of similar clinical presentations date back to 1897 [14–16]. Parsonage Turner syndrome usually affects the upper trunk of the brachial plexus or peripheral nerves in the shoulder girdle with rare involvement of the middle and lower trunks [14, 17]. The suprascapular, long thoracic, and axillary nerves are the most commonly involved peripheral nerves with the musculocutaneous, anterior interosseous, ulnar, and median nerves also being occasionally involved [14, 17–22]. The exact etiology of the disorder is not fully understood, but 25% of cases occur after a viral infection, and 15% occur after immunization [14]. Parsonage Turner syndrome has also been seen after exercise and surgery [14, 23, 24].

Diagnosis of LACN entrapment depends on a good history and physical examination with knowledge of the nerve pathway within the arm. A diagnostic injection of local anesthetic can help differentiate between elbow pain, secondary to entrapment of the LACN, and other causes such as lateral epicondylitis or radial tunnel syndrome [25]. When the injury is below the coracobrachialis muscle, the predominant symptom is weakness of the biceps brachii and brachialis muscles in addition to paresthesia along the LACN distribution [26]. The nerve is compressed between the distal biceps tendon and brachialis muscle. This mechanism of compression has been attributed to windsurfing when the arm is flexed for long periods of time or during forceful extension [5, 27]. Vigorous exercise consisting of elbow extension and forearm pronation has been associated with this condition as well [2]. Symptoms may include pain, paresthesia, and numbness over the radial aspect of the forearm [1]. Although the LACN is a purely sensory nerve, most of the patients complain of pain rather than paresthesia [25]. Symptoms of entrapment of the LACN may mimic other causes of lateral elbow pain such as lateral epicondylitis and radial tunnel syndrome [25]. This condition should be differentiated from bicipital tendon rupture or a brachial plexopathy that may on occasion follow minor trauma and is typically painful. These pathologies need to be further differentiated from possible cervical radiculopathy in which muscles other than the biceps brachii and brachialis are affected [1].

Neuropathic pain can be complicated and involves several molecular pathways, making its treatment difficult.

Currently available medications do not act on all the mechanisms underlying the generation and propagation of this type of pain. They often act only on the temporal pain properties rather than targeting the several mechanisms responsible for its generation and propagation. Attempts to control pain at the molecular level have lead to the introduction of antisense strategies as well as gene, stem cell, and viral therapies. Given the complex nature of pain, a multifaceted approach appears to be necessary for successful pain management [28].

It has been noted that cytokine activation or dysregulation is implicated in multiple disease states [29]. Experimental studies have shown that proinflammatory cytokines induce or facilitate neuropathic pain. Cytokine levels are increased in the peripheral nerves, dorsal root ganglia, spinal cord, and in certain regions of the brain after peripheral nerve injuries. Anticytokine therapies currently on the market are effective mostly for inflammatory pain conditions and need to be further tested to determine their efficacy for neuropathic pain. Agents have been identified that more specifically target downstream signals that may provide new tools for more specific therapies [29]. Other studies have noted that peripheral nerves synthesize and metabolize neuroactive steroids, which also express classical and nonclassical steroid receptors [30]. Neuroactive steroids modulate the expression of transcription factors for Schwann cell function, regulate Schwann cell proliferation, and promote the expression of myelin proteins involved in the maintenance of myelin multilamellar structures [30]. Neuroactive steroids, such as testosterone, progesterone, and their metabolites, may represent a promising therapeutic option as well [30].

Although the above-mentioned experimental treatments may one day lead to better treatment of neuropathic pain, current treatments of musculocutaneous neuropathy and its branches are limited to relative rest, NSAIDs, a posterior elbow splint to prevent full extension, and physical therapy. If symptoms persist beyond 6 weeks, injection of steroid and local anesthetic into the musculocutaneous tunnel may be performed in order to possibly alleviate the inflammatory component of the pain [26, 31]. After 12 weeks of unsuccessful nonoperative treatment for these neuropathies, surgical decompression is often advised [2, 4]. In a series of 15 patients presenting with symptoms of LACN compression, 11 were successfully treated with surgical decom-

pression that involved resecting a triangular wedge of aponeurosis overlying the nerve [3].

Although the mechanism of injury in the case presented was similar to that previously reported in the literature, the clinical picture was somewhat different. The patient described the pain as starting from the shoulder girdle and radiating along the musculocutaneous nerve and over the lateral antebrachial cutaneous nerve distribution. Musculocutaneous nerve injury may present with an atypical clinical picture, and therefore, an EMG/NCS may aid in confirming the diagnosis in order to initiate the proper treatment in a timely fashion.

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