비전형적 신경다발 침범을 보인 주관절부 척골신경병증: 수술 전후 소견

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Pre- and Postoperative Electrodiagnostic and Operative Findings on Atypical Fascicular Involvement of Ulnar Neuropathy at the Elbow: A Case Report

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A 46-year old male was referred with complaint of tingling sensation of right 4, 5th fingers which aggravated on elbow flexion. He has history of proximal radius fracture six months ago. The standard nerve conduction studies were all normal including ulnar segmental motor conduction study with abductor digiti minimi and first dorsal interosseous recordings and ulnar sensory segmental studies across the elbow. However, the segmental motor conduction study demonstrated amplitude drop with above elbow stimulation with needle recording in flexor carpi ulnaris and flexor digitorum profundus that showed abnormal findings in needle EMG. The segmental sensory conduction study of dorsal ulnar cutaneous nerve also revealed amplitude reduction with above elbow stimulation. Imaging studies of the elbow uncovered bony fragment around the medial epicondyle. The patient received surgery: osseous fragment excision, neurolysis and anterior transposition of the ulnar nerve. In post-operative study, previous electrodiagnostic findings were all normalized with clinical improvement.

Key Words: electromyography, neural conduction, ulnar neuropathy at elbow

Introduction

The most common vulnerable point in ulnar neuropathy is the elbow medial epicondyle. Occasionally, the ulnar nerve can be partially affected with fascicular involvement. Stewart^{1,2} described the distribution of fascicular involvement patterns of ulnar neuropathies. The studies discovered that most commonly involved

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motor branches in ulnar neuropathy at the elbow (UNE) were branches to the abductor digiti minimi (ADM) and the first dorsal interosseous (FDI) muscles, whereas one of these cases solely involved the flexor carpi ulnaris (FCU). None of these UNE cases solely involved flexor digitorum profundus (FDP). We report an atypical case of UNE that predominantly involved the fascicles to the FCU and FDP muscles and dorsal ulnar cutaneous nerve (DUCN), which relatively spared the hand intrinsic muscles and ulnar sensory nerve. To the best of our knowledge, this is the first case to report UNE with atypical fascicular involvement of FCU, FDP and DUCN.

Case Report

A 46-year-old healthy man complaining of tingling sensation on his right 4th and 5th fingers visited the Department of Physical Medicine and Rehabilitation. Six months ago, he slipped and fell on the floor, which resulted in a hairline fracture on the right proximal ra-

dius. A long arm cast was applied with elbow flexion position for 6 weeks. He started exercise therapy for limited range of motion of the elbow joint 2 months after the injury and developed tingling sensation on the 4th and 5th fingers 6 weeks after the exercise therapy especially when elbow is flexed. The patient was referred for electromyography (EMG) 6 months after the injury. On physical examination, the manual muscle test was grossly normal in the right upper extremity including the ulnar innervated muscles and C8 myotome. Sensory examination revealed hypoesthesia in the dorsum of the right 4th and 5th fingers, and Tinel's sign was positive on the right elbow tapping over the ulnar nerve.

The right median motor and sensory conduction studies were normal. The right ulnar segmental motor conduction studies with ADM and FDI recordings and ulnar sensory nerve segmental conduction studies were within the normal limits. The stimulation points of the segmental conduction studies were as follows; wrist, 8 cm and 14 cm proximal to the recording electrodes

Table 1. Motor Nerve Conduction Study (Pre- and Post-operative)

Study	Nerve	Stimulation	Recording	Latency (msec)	Amplitude (mV)	Distance (cm)/ NCV (m/sec)
Pre-operative	Rt. Ulnar	Wrist	ADM	2.7	11.5	
		BE	ADM	6.2	10.5	20/57
		AE	ADM	8.0	9.5	10/56
	Rt. Ulnar	Wrist	FDI	4.1	14.1	
		BE	FDI	7.6	14.1	20.5/59
		AE	FDI	9.1	13.0	10/67
	Rt. Ulnar	BE	FCU [†]	2.4	13.2	
		AE	FCU [†]	3.8	7.3*	10/71
	Rt. Ulnar	BE	FDP [†]	2.1	9.6	
		AE	FDP [†]	3.9	3.2*	10/56
	Rt. Median	Wrist	APB	3.5	6.4	
		Elbow	APB	7.2	5.9	21.5/58
	Lt. Ulnar	Wrist	ADM	2.4	9.4	
		BE	ADM	5.6	9.3	18.5/56
		AE	ADM	7.6	8.6	10/50
Post-operative	Rt. Ulnar	BE	FCU [†]	2.0	15.6	
		AE	FCU [†]	3.7	15.1	10/59
	Rt. Ulnar	BE	FDP [†]	2.5	8.4	
		AE	FDP [†]	4.5	8.3	10/50

The abnormal electrophysiologic value is marked with an asterisk(*)

NCV: nerve conduction velocity, Rt.: right, Lt.: left, BE: below elbow, AE: above elbow, ADM: abductor digiti minimi, FDI: first dorsal interosseous, FCU: flexor carpi ulnaris, FDP: flexor digitorum profundus, APB: abductor pollicis brevis

[†]The needle electrodes were used for FCU and FDP recordings

for motor and sensory conduction studies, respectively; below elbow, 3 cm distal to the medial epicondyle; above elbow, 7 cm proximal to the medial epicondyle. The inching study of ulnar nerve at the ADM and FDI recordings were not conducted because the segmental conduction studies showed no abnormal findings. We made an approach to possible atypical ulnar neuropathy with segmental motor conduction study with needle recording in FCU and FDP that showed abnormal findings in needle EMG and with segmental sensory conduction study of DUCN. These studies demonstrated amplitude reduction with above elbow stimulation (Table 1, 2).

On needle EMG, fibrillation potentials and positive sharp waves were observed in the right FCU and FDP with polyphasic motor unit action potentials and reduced recruitment patterns, whereas the FDI and ADM muscles revealed positive sharp waves and minimally reduced recruitment patterns. Other muscles were normal (Table 3).

These electrophysiologic findings suggested incomplete right UNE that predominantly involved the fascicles to the FCU and FDP muscles and DUCN, which can be interpreted as partial conduction block.

The ultrasonography conducted on the same day revealed a bony fragment around the right cubital tun-

Table 2. Sensory Nerve Conduction Study (Pre- and Post-operative)

Study	Nerve	Stimulation	Recording	Onset/peak latency (msec)	Amplitude (μ V)
Pre-operative	Rt. Ulnar	Wrist	V digit	2.4/3.0	27.8
		BE	V digit	5.4/6.0	16.9
		AE	V digit	7.4/8.2	11.4
	Rt. DUCN	Forearm	4 th web space	1.8/2.2	37.8
		BE	4 th web space	4.5/4.9	21.7
		AE	4 th web space	6.2/6.6	8.0*
	Rt. Median	Wrist	III digit	2.0/2.7	53.1
		Palm	III digit	1.0/1.5	68.4
	Lt. Ulnar	Wrist	V digit	1.3/1.7	28.4
		BE	V digit	3.7/4.2	19.5
		AE	V digit	5.4/5.8	14.2
	Lt. DUCN	Forearm	4 th web space	1.6/2.2	21.9
		BE	4 th web space	3.8/4.3	15.8
		AE	4 th web space	5.6/6.2	13.0
Post-operative	Rt. DUCN	Forearm	4 th web space	1.3/1.8	40.5
		BE	4 th web space	4.3/4.8	23.6
		AE	4 th web space	5.8/6.4	19.9

The abnormal electrophysiologic value is marked with an asterisk (*)

Rt.: right, Lt.: left, BE: below elbow, AE: above elbow, DUCN: dorsal ulnar cutaneous nerve

Table 3. Needle Electromyography Study (Pre- and Post-operative)

Study (Rt.)	Muscle	Insertional activity	Spontaneous activity	Motor unit action potentials	Recruitment pattern
Pre-op	Brachioradialis	Normal	–	Normal	Normal
	Pronator teres	Normal	–	Normal	Normal
	Flexor carpi ulnaris		F&P(++)	Inc. polys	R
	Flexor digitorum profundus		F&P(++)	Polys	R
	Abductor digiti minimi		P(+)	Inc. polys	min R
	First dorsal interosseous		P(+)	Inc. polys	min R
	C6/7, C7/T1 PVMs	Normal	–		
Post-op	Flexor carpi ulnaris	Normal	–	Normal	Normal
	Flexor digitorum profundus	Normal	–	Normal	Normal
	Abductor digiti minimi	Normal	–	Normal	Normal
	First dorsal interossei	Normal	–	Normal	Normal

Rt.: right, op: operative, F: fibrillation potentials, P: positive sharp waves, Inc.: increased, R: reduced, min: minimally, PVM: paravertebral muscle

Fig. 1. (A) Pre-operative computed tomography finding. The osseous proliferation (arrow) at the medial aspect of the right olecranon. (B) Pre-operative ultrasonography at the elbow. The ulnar nerve (surrounded in a dashed line) is located between the medial epicondyle (ME) and the osseous fragment (*, asterisk). (C) Pre-operative x-ray finding and (D) Post-operative x-ray finding. The osseous proliferation fragment (marked with a circle) was removed by surgery.

nel area and slightly swollen ulnar nerve at the same level with the bony fragment. The elbow x-ray and the computed tomography conducted 9 months after the injury revealed osseous proliferation of the previously confirmed bony fragment in the medial aspect of the olecranon that encroaches the cubital tunnel (Fig. 1).

The patient underwent osseous fragment excision, neurolysis, and anterior transposition of the ulnar nerve (Fig. 2).

On the follow-up visit for EMG 2 months postoperatively, the tingling sensation in the right 4th and 5th fingers disappeared. Electrophysiologic findings of the conduction block were completely resolved in the ulnar motor conduction study with FCU and FDP recordings and DUCN conduction study (Table 1, 2). The needle EMG findings were also normal (Table 3). The follow-up x-ray of the elbow confirmed the osseous fragment resection (Fig. 1).

Discussion

Electrodiagnostic study is critical for the differential diagnosis of ulnar neuropathy from the lower brachial plexus or C8-T1 root lesions and is also useful to determine the level of ulnar neuropathy. Through segmental nerve conduction study and with inching techniques of motor or sensory nerves, the lesion could be localized

Fig. 2. Operative findings: ulnar nerve swelling due to compression of bony fragment (*) between the medial epicondyle and the olecranon. The osseous fragment excision and anterior transposition of the ulnar nerve were performed.

precisely. In UNE, the sensitivity of nerve conduction studies was reported 37% to 100% in previous studies.³ The other study reported 78% sensitivity of conduction study, and additional sonography increased the sensitivity up to 98%.⁴

Most of the UNE predominantly involves the hand intrinsic muscles. The ulnar nerve motor conduction study has two recording options: ADM and FDI muscles. In previous studies, Kothari⁵ et al. reported higher sensitivity of FDI recording in UNE, whereas Shakir⁶ et al. reported higher sensitivity of ADM muscle recordings. Park⁷ et al. recommended both ADM and FDI

recordings because some patients revealed abnormal findings in only one recording. These are also the results of selectivity of fascicular involvement.

Motor conduction study with needle recording is not usually recommended because it may reflect only a part of the muscle. However, it may contribute to correct diagnosis when applied cautiously. In the process of electrodiagnostic examination on this patient, the ulnar motor and sensory segmental conduction studies were normal. On the needle EMG, FCU and FDP muscles revealed fibrillation and positive sharp waves with reduced recruitment patterns, whereas FDI and ADM muscles were relatively spared. Then, the segmental motor conduction studies were performed in FCU and FDP with needle recordings to eliminate the volume-conducted responses from the other muscles of the forearm. We tried carefully to maintain the same morphology of the CMAP in each stimulation.⁸ The CMAPs evoked from the above-elbow stimulation revealed reduced amplitude in both FCU and FDP muscle recordings. A segmental conduction study of the DUCN was performed and also revealed amplitude reduction with the above-elbow stimulation. The criteria of amplitude reduction in DUCN segmental conduction study were used with that of ulnar sensory segmental conduction study in a previous report.⁹

This is an unusual case of UNE predominantly involving the fascicles to the FCU and FDP muscles and DUCN, whereas most of the UNE predominantly involves the hand intrinsic muscles. The intraneural topography of ulnar nerve is accountable for this fascicular involvement pattern. Because the ulnar motor nerve fascicles innervating FCU, FDP and DUCN sensory nerve fascicles are closer to the medial epicondyle than the other fascicles of ulnar nerve,¹⁰ the atypical

involvement pattern of UNE in this case can be explained. This electrodiagnosis was supported by clinical and electrodiagnostic improvement postoperatively.

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