The Incidence of Ulnar Nerve Subluxation in Patients with Ulnar Neuropathy at the Elbow and Healthy Control: A Clinical, Electrodiagnostic, and Ultrasonographic Study

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Abstract

Background: Ulnar neuropathy at the elbow is a common presenting disorder in neuromuscular medicine. Patients suffer from paresthesia in the 4/5 finger, pain at the elbow, and weakness and atrophy in advanced cases. **Objective:** This study aimed to find the incidence of ulnar nerve subluxation in patients with ulnar neuropathy at the elbow. **Materials and Methods:** This is a case-control study conducted in Al-Sadiq teaching hospital at the period of January 2018–August 2022. It included 84 patients diagnosed with ulnar neuropathy at the elbow by history, clinical examination and electrodiagnostic testing. All patients and control undergo ultrasonographic examination by high-resolution ultrasound looking for ulnar nerve cross-sectional area at 3 points: (1) 7 cm proximal to medial epicondyle, (2) at the medial epicondyle, and (3) at the cubital tunnel 2-3 cm distal to medial epicondyle. Also, dynamic ultrasonographic examination were done looking for subluxation of ulnar nerve behind medial epicondyle during elbow flexion. If ulnar nerve move on the top of medial epicondyle it is considered partial and when it dislocates anteriorly beyond the tip of medial epicondyle it is considered complete subluxation.

Keywords: Dynamic ultrasound, ulnar nerve subluxation, ulnar neuropathy at the elbow

Introduction

Ulnar neuropathy at the elbow (UNE) is the second most common entrapment neuropathy after median nerve entrapment at the carpal tunnel. Commonly patients presented with paresthesia and numbness of the little and medial half of ring finger, in addition to weakness and atrophy of intrinsic hand muscles supplied by ulnar nerve mostly seen in advanced cases.[1]

The diagnosis of UNE is confirmed by electrodiagnostic study, with nerve conduction studies (NCSs) the most commonly employed test. Multiple NCS techniques are available like comparing the amplitude of compound muscle action potential (CMAP) and conduction velocity between the above and below elbow sites recording from abductor digiti minimi and first dorsal interosseus muscles, inching technique, and sensory NCS. These techniques are very useful and are capable of localizing nerve entrapment at the elbow in 38%–89%[2] of cases especially when the pathophysiology is demyelinating type. The difficulty arises when axonal degeneration and nonlocalizing ulnar neuropathy were set. In axonal ulnar nerve lesion, the most useful test is electromyographic examination of ulnar innervated muscles, which can localize the compression proximal to the innervation of flexor carpi ulnaris, and thus, it is said that the compression at or above the elbow.[3]

This has changed dramatically after the use of high-resolution ultrasonography in assessing neuromuscular disorders. It enables us to localize ulnar nerve entrapment more accurately and also to characterize it more appropriately. In addition to that, ultrasound examination allows us to elicit congenital anomaly of

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the nerve.[4] Ulnar nerve displacement (subluxation) behind medial epicondyle of humerus during elbow flexion is one of these congenital anomalies that has been sought previously with controversy about its importance and incidence as a cause of ulnar nerve pathology. It is reported in both normal subjects and patients with ulnar nerve entrapment. The recognition of this anomaly is important because it alters the electrodiagnostic findings by falsely increasing the conduction velocity across the elbow or pseudoconduction block making the diagnosis of UNE more challenging. The advent of ultrasound has increased the awareness of this congenital anomaly, so, many researches are conducted to decipher its impact.[5]

This study aimed to find the incidence of ulnar nerve subluxation in patients with UNE.

Materials and Methods

Study design

This is a case–control study conducted from the period of January 2018 to August 2022.

Study sample selection

The study included 84 patients with UNE matched against 80 normal apparently healthy control who have comparable age and sex. Patients were selected randomly from the outpatient clinic of the Neurophysiology Department of Al-Imam Al-Sadiq Hospital in Babylon, Iraq.

Patients suffering from classical symptoms of ulnar neuropathy, such as paresthesia and weakness of ring and little fingers with weakness of ulnar innervated muscles, were selected and referred to the electrodiagnostic laboratory. The diagnosis of UNE was confirmed by electrodiagnostic and ultrasonographic studies[6] according to the diagnostic criteria shown below.

Exclusion criteria were the presence of peripheral neuropathy by history, examination or electrodiagnostic study, ulnar nerve surgery, and trauma to the elbow.

The study was approved by the local health ethical committee and written consent was obtained from each patient.

Normal apparently healthy control consisted of volunteers and family members of patients enrolled in the study. The control group matches the patient group in age, sex, and number. They undergo the same clinical and electrodiagnostic examinations as the patient group. The control group was used to find the incidence of ulnar nerve subluxation and cutoff value of the cross-sectional area (CSA) of ulnar nerve.

Clinical assessment

Both patients and control were assessed clinically by history and physical examination including detailed neurological examination. History includes focusing on symptoms of UNE like paresthesia and loss of sensation in the little and medial half of the ring finger, in addition to the dorsal side of the hand. Complaints of motor weakness and clumsiness were also assessed. Examination includes observation of abnormal hand posture like Benediction's posture, Froment's sign, Wartenberg sign, and any visible atrophy of ulnar innervated intrinsic hand muscles. In addition to that, provocative maneuvers were done like Tinel's sign, ulnar nerve tenderness, and nerve thickening. Finally, pinprick sensation and power examination were done for ulnar innervated skin and muscles of the hand. Clinical assessment was done by experienced neurologist who obtained history and did physical examination.

Electrodiagnostic assessment

Electrodiagnostic study was done using Nihon Kohden machine 2014. NCS of median and ulnar nerves was done for each patient bilaterally. At first, skin temperature was monitored to be below 34 C, and patient and control were informed about the nature of the test. Median nerve sensory examination was done recording at the index or middle finger and stimulating at the wrist 12 cm proximal from the recording electrode.

Ulnar sensory responses were obtained by recording over the little finger and stimulating at the medial side of the wrist 12 cm distance from the recording electrode.

Median motor response was obtained by recording over abductor pollicis brevis muscles and stimulating at the wrist (5 cm from recording electrode) and antecubital fossa.

Ulnar motor study was performed recording at the abductor digiti minimi and first dorsal interosseus and stimulating at the wrist (5 cm distance from recording electrode) and below and above the elbow (8 cm distance between the two sites).

F-wave study was recorded for both ulnar and median nerves.

All stimulations were supramaximal with fixation of the hand during stimulation to prevent movement. Ulnar nerve stimulation at the elbow was done while the joint was in 90° flexion. The distance was measured between the active electrode and the negative pole of the stimulating electrode to calculate conduction velocity.

Distal motor latency, amplitude, and conduction velocity were measured at each stimulation site.

The electrodiagnostic testing was done by experienced electrodiagnostician.

Criteria of UNE:

1 Conduction block between below and above elbow segment defined as reduction in amplitude >20% with <15% prolongation of CMAP area.
2 Focal slowing across elbow defined as conduction velocity <45 m/s or difference from wrist-below elbow segment >10 m/s.

3 Nonlocalizing lesion defined as low CMAP amplitude of ulnar nerve recording abductor digiti minimi <5 mv or 50% amplitude reduction compared with contralateral side.[6]

Ultrasonographic examination

Ultrasonographic examination was done using Clarius using 8–14 MHz linear array transducer. Patient was lying flat with his elbow flexed about 60°–70° on his side and supported on the couch. Scanning of ulnar nerve started from the wrist up to the elbow and then to the mid-arm. Scanning was done both by short- and long-axis views. Parameters assessed include CSA on transverse imaging, subjective assessment of echogenicity, and fascicular architecture with state of surrounding tissues. CSA was measured at three sites, (a) 7–8 cm proximal to medial epicondyle, (b) immediately proximal to the medial epicondyle, and (c) at the cubital tunnel 2–3 cm distal to the medial epicondyle. The measurement was done by tracing technique inside the hyperechoic border of nerve epineurium. All examinations were done with minimal pressure and application of plenty amount of ultrasound gel.

The criteria of UNE using ultrasound were CSA of ulnar nerve at positions 2 and 3 of more than 9 mm or greater than 100% increase in areas 2 and 3 compared with the first position (7–8 cm proximal to medial epicondyle).[6]

Dynamic examination was performed with the elbow fully flexed to 135° to assess the position of ulnar nerve and classified as (1) normal when the nerve remains lateral to the medial epicondyle, (2) partial luxation when the nerve moved on the top of the epicondyle, and (3) total luxation when the nerve dislocated anteriorly beyond the tip of medial epicondyle.[5]

All sonographic examination was done by an electrodiagnostician who is well-trained with neuromuscular ultrasonography. Each measurement of CSA was done three times, and average measurement was considered as the final measurement. The examiner was blinded to the clinical and electrodiagnostic data and examined both upper limbs.

Statistical analysis

The data were collected, revised, and introduced to computer program (SPSS, IBM statistics, California, USA) version 20. Mean ± standard deviation was calculated for quantitative measures, and comparison was made between patients and control. Receiver operator characteristic curve was used to find the sensitivity and specificity of the test. Results are considered significant when the *P* value was less than 0.05.

Ethical approval

The study was conducted in accordance with the ethical principles. The study protocol was reviewed and approved by the Ethical Committee of the College of Medicine/Babylon University, document number 1789 on December 30, 2017.

Results

Demographic and clinical data

Demographic and clinical data of the study group are shown in Table 1. No significant difference was found in age and gender characteristics between patients and control. Also, the most frequently reported symptom was paresthesia of little and ring fingers (digit 4/5). In addition, significant group of patients suffer from pain in the hand.

Ulnar nerve ultrasound

Table 2 shows the findings of ulnar nerve ultrasound in UNE patients and control. Of 84 UNE patients examined, 30 (35%) were found to have ulnar nerve subluxation, 18 (21%) have partial ulnar nerve subluxation, and 12 (14%) had complete subluxation. In addition to that, CSA of ulnar nerve shows statistical significant difference when compared with the control group mainly at the medial epicondyle

On the other hand, ultrasonographic characteristic of controls shows that of 80 persons examined, eight (10%) were found to have partial ulnar nerve subluxation and five (6.25%) complete subluxation.

Statistical analysis of the above data shows statistically significant differences between UNE patients and control regarding ulnar nerve CSA at the medial epicondyle.

In spite of that, no significant difference was found in ulnar nerve CSA in patients with subluxation (partial and

Table 1: Demographic and clinical data of study group

Variable	UNE patients (84)	Control (80)
Age	44.3 ± 11	40 ± 9
gender (male/ female ratio)	50/33	49/31
Paresthesia of digit 4/5	80 (95%)	
Elbow pain	60 (71%)	
Weakness	11 (13%)	
atrophy	9 (10.7%)	

Table 2: Ultrasonographic measurements of patients and control

Variable	UNE patients	Control	*P* value
Ulnar nerve CSA at 7 cm proximal to medial epicondyle (cm)	6.3 ± 3	6.1 ± 2.2	0.6
Ulnar CSA at medial epicondyle (cm)	16.6 ± 6	10 ± 1.9	0.0001
Ulnar CSA at cubital tunnel (cm)	6 ± 1.9	6.9 ± 2	0.0036
Ulnar subluxation	30 (35%)	13 (16.25	
Complete ulnar subluxation	12 (14%)	5 (6.25%)	
Partial ulnar subluxation	18 (21%)	8 (10%)	

Table 3: Difference between cross-sectional area of ulnar nerve in patients with subluxation and patients without

Variable	UNE patients with subluxation	UNE without subluxation	*P* value
Ulnar CSA 7 cm proximal to medial epicondyle (cm)	6.1 ± 1	6.9 ± 2.1	0.09
Ulnar CSA at medial epicondyle (cm)	16.7 ± 3.3	15.7 ± 5.3	0.4
Ulnar CSA at cubital tunnel (cm)	6.5 ± 2	6.2 ± 1.2	0.6

complete) when compared with UNE patients without subluxation, as shown in Table 3.

Discussion

This case–control study was designed to test the importance of ulnar nerve subluxation at the elbow as a cause or predisposing factor of ulnar nerve entrapment. The study found that ulnar nerve subluxation was more prevalent in UNE patients compared with healthy control, especially the complete type when the ulnar nerve moved completely behind the medial epicondyle making the nerve superficial between bone and skin and so more vulnerable to chronic irritation and injury.[7]

Earlier dynamic ultrasonographic studies show comparable findings of ulnar nerve subluxation and agree with our study, Filippou *et al*.[8] in 2010 found that 18.7% of UNE patients have partial ulnar subluxation and 9.9% show complete type compared with 14% for partial and 6.7% for complete subluxation reported by Van Den Berg *et al*. in 2012.[7]

Ulnar nerve subluxation in healthy control has not been studied extensively, we found four earlier studies that incorporate dynamic ultrasonographic assessment of ulnar nerve. The percentage of ulnar nerve subluxation was different between these studies starting from lesser incidence of these studies, which was 5.1% showing complete and 11.1% showing partial subluxation,[7] whereas Kim *et al*. in 2005 found higher incidence of 20% complete and 27% partial subluxation. Other two studies show intermediate findings.

On the other hand, the impact of ulnar subluxation on UNE was studied in several earlier researches with conflicting results and conclusions with many investigators showing no difference in the incidence of ulnar nerve subluxation between UNE patients and control like Omejec and Podnar[9] in 2015 and others show that subluxation could be a predisposing factor for ulnar nerve pathology at the elbow like Filippou *et al*.[8]

In spite of that, all the literature and researchers focus on the importance of dynamic assessment of ulnar nerve in patients with UNE. Also, many researchers and authors explained that the role of ulnar nerve subluxation in predisposing to entrapment at the elbow is questioned especially if complete subluxation like Leis *et al*.,[10] in 2016, who found that complete subluxation is found in contralateral arm of patients with UNE. Therefore, they suggested that complete ulnar subluxation might be protective against UNE.

One of the important issues that should be addressed in ulnar nerve subluxation is the false decrement of distance across the elbow and then the wrong calculation of conduction velocity, which might affect the sensitivity and NCS in diagnosing UNE.

Conclusion

Ulnar nerve subluxation is more common in patients with UNE and might be a predisposing factor for it, mainly the partial type.

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Conflicts of interest

There are no conflicts of interest.

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