Clinical Neurophysiology 127 (2016) 2728–2732

Contents lists available at ScienceDirect

Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

Prolonged phone-call posture causes changes of ulnar motor nerve conduction across elbow

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ARTICLE INFO

Article history:
Accepted 9 May 2016
Available online 25 May 2016

Keywords:
Ulnar neuropathy at elbow
Nerve entrapment syndrome
Neuropathy
Ulnar nerve
Mobile phone
Epidemiology

HIGHLIGHTS

- Calling by mobile phone forces the elbow in flexed position.
- The study assesses ulnar nerve function changes during a 18 min phone posture, comparing subjects with minimal clinical UNE and symptom-free subjects.
- Motor nerve conduction of ulnar nerve across the elbow decreases significantly in the UNE group during prolonged phone posture.

ABSTRACT

Objective: Postures and work-hobby activities may play a role in the origin and progression of ulnar neuropathy at the elbow (UNE), whose occurrence appears to be increasing. The time spent on mobile-phone has increased in the last decades leading to an increased time spent with flexed elbow (prolonged-phone-posture, PPP). We aimed to assess the effect of PPP both in patients with symptoms of UNE and in symptom-free subjects.
Methods: Patients with pure sensory symptoms of UNE and negative neurophysiological tests (MIN-UNE) and symptom-free subjects were enrolled. We evaluated ulnar motor nerve conduction velocity across elbow at baseline and after 6, 9, 12, 15, and 18 min of PPP in both groups. Fifty-six symptom-free subjects and fifty-eight patients were enrolled. Globally 186 ulnar nerves from 114 subjects were studied.
Results: Conduction velocity of ulnar nerve across the elbow significantly changed over PPP time in patients with MIN-UNE, showing a different evolution between the two groups.
Conclusions: PPP causes a modification of ulnar nerve functionality in patients with MIN-UNE.
Significance: PPP may cause transient stress of ulnar nerve at elbow.

1. Introduction

Nerve entrapment syndromes are mononeuropathies occurring in regions anatomically predisposed to compression. They are often related to dynamic processes involving surrounding tendons, muscles, bones, and usually occur close to a joint. Posture, habits and other activities may have a crucial role in the change of nerve entrapments (Andersen et al., 2012; Bartels and Verbeek, 2007; Descatha et al., 2004; Palmer et al., 2007; Richardson and Jamieson, 2004; Strömberg et al., 1997).

Technologies may modify life culture but also postural habits and behavior. In recent years the use of mobile phones has significantly increased, especially in young people (Söderqvist et al., 2007). The mobile phone gave the opportunity to broaden human relationships and time spent on phone-calls drastically increased in the last decades. This dramatically increased the time with flexed elbow in a prolonged phone posture (PPP), when a call is ongoing (unless headphone or Bluetooth earphone are used), in

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http://dx.doi.org/10.1016/j.clinph.2016.05.010
1388-2457/

order to hold the device close to the ear and mouth, for listening and speaking, respectively (see Fig. 1). Even when typing on the mobile devices, 52% of people keep the elbow flexed at less than 90° (Gold et al., 2012).

Ulnar neuropathy at elbow (UNE) is a common entrapment syndrome (second only to carpal tunnel syndrome) (Caliandro et al., 2011; Mondelli et al., 2005) causing paresthesias at IV and V fingers and, in more severe cases, weakness or hypotrophy of ulnar intrinsic muscles with consequent severe disability. UNE may be entrapped at different sites. The entrapment can mainly occur in four anatomical points: (1) medial intermuscular septum of arm, a septum that extends from the humerus to the medial epicondyle; (2) retroepicondylar groove, that represents the most common condition; (3) humeroulnar aponeurotic arcade, that represents 25% of cases and is the only condition for which "cubital tunnel syndrome" should be used; (4) outlet from flexor carpi ulnaris muscle (not strictly in the elbow) (Landau and Campbell, 2013). Several diverse mechanical and dynamical factors may contribute to nerve compression: the nerve passes behind a joint with wide range of motion; it is located within a groove, in touch with the bone, and is very superficial (with exposition to external compression); moreover, the tendon of triceps is located in the groove and it can significantly moves; finally, in flexion, the olecranon moves toward, increasing the tension of the humeroulnar aponeurotic arcade and pressure in the groove increases up to 200 mmHg (Millesi et al., 1990; Werner et al., 1985; Wright et al., 2001).

Although no recent data are available on UNE epidemiology [an exhaustive paper on Italian population was published (Mondelli et al., 2005)], in our neurophysiological lab we observed that the occurrence of UNE has absolutely (56 patients in 1998; 87 patients in 2013) and relatively increased (4% of the examinations in 1998; 7% of the examinations in 2013) during the last 15 years (unpublished data). This is unlikely due to increased electro-diagnostic sensitivity, as instead occurred for carpal tunnel syndrome (Padua et al., 1997), but may reflect higher incidence/prevalence of UNE.

Motor nerve conduction velocity across elbow is the most sensitive neurophysiological measure to assess ulnar nerve function at elbow (Padua et al., 2001; Logigian et al., 2014). In order to evaluate ulnar nerve function changes during PPP, we assessed nerve conduction velocity during a simulated PPP in two groups: a group of patients with minimal UNE (defined as typical clinical UNE with pure sensory symptoms and negative standard neurophysiological tests, MIN-UNE) and symptom-free subjects. We chose to study patients with minimal UNE because it is commonly accepted that

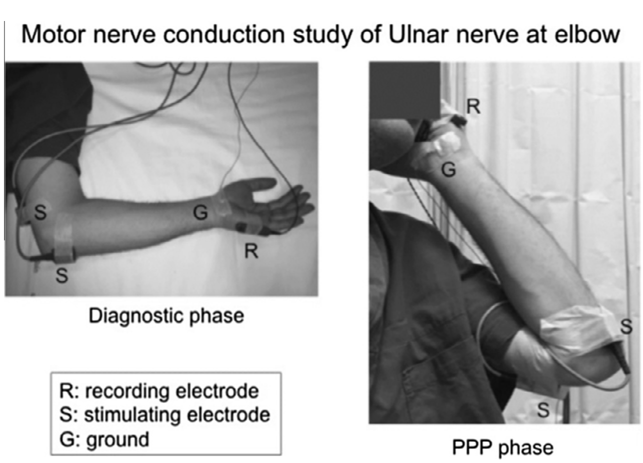

Fig. 1. The pictures show the position of the elbow during both the diagnostic phase and the PPP phase of the neurophysiological examination.

patients with UNE should avoid prolonged flexed elbow posture (Padua et al., 2002) and it would not have been ethical to submit patients to this procedure.

Translational results of this study are to evaluate if PPP may cause significant changes of ulnar nerve function across the elbow.

2. Methods

After signed informed consent, patients with MIN-UNE were enrolled, if they met two or more following clinical-neurophysiological criteria: (1) history of paresthesias and/or numbness at the fourth and fifth digits; (2) sensory symptoms at the fourth and fifth digits following prolonged elbow flexion; (3) sensory deficits in ulnar distribution (Caliandro et al., 2008). The exclusion criteria were: (1) clinical or neurophysiological (see below) signs of polyneuropathy, (2) previous decompression surgery for UNE, (3) clinical or neurophysiological signs of radiculopathy, plexopathy and ulnar neuropathy at Guyon's canal (diagnoses that may mimic UNE). Since the study was focused on minimal UNE cases, patients with weakness or hypotrophy of ulnar innervated hand muscles and with slowing of motor conduction velocity at elbow (see below) were excluded. All subjects were clinically extensively assessed to exclude focal damage of ulnar nerve out of elbow or C8-T1 root involvements. Control group included age matched symptom-free subjects. This study was approved by the local ethics committee. All patients gave written informed consent before enrolment.

2.1. Clinical evaluation

After an accurate clinical history, nerve evaluation was performed as follows: (1) provocative testing with prolonged (one minute) passive forced elbow flexion; (2) thenar and hypothenar eminences trophism assessment; (3) strength evaluation of median and ulnar innervated muscles; (4) evaluation, through cotton wool, of sensory function in ulnar and median innervated hand regions. Extended neurological examination was always performed to exclude concomitant diseases.

2.2. Neurophysiologic evaluation

Neurophysiological studies were performed with a Synergy Cardinal electromyography machine. An infrared lamp was used to maintain hand skin temperatures >31 °C during all tests. Neurophysiological evaluation was divided in two parts, the *diagnostic phase* and *PPP phase.* The first was to exclude systemic or other diseases involving ulnar nerve, while the second was to evaluate PPP changes of ulnar motor nerve conduction velocity at elbow.

2.2.1. Diagnostic phase

The following neurophysiological protocol for ulnar nerve was performed: (1) sensory nerve conduction from fifth digit to wrist; (2) motor nerve conduction in the following segments: arm, across elbow (U-AE) over a 8–10 cm segment, and forearm (U-FO); and (3) wrist-abductor digiti minimi (ADM) distal motor latency.

According to our neurophysiological protocol, to assess sensory nerve conduction velocities, stimulating ring electrodes were applied to the fifth fingers with the cathode over the proximal phalanx and the anode over the middle (or, in the case of the thumb, distal) phalanx. Recording electrodes mounted on a plastic bar (interelectrode distance, 2.5 cm) were applied to the wrist over the radial, median and ulnar nerves. The ground electrode was attached between the stimulating and recording electrodes. Supramaximal stimuli of 0.1 ms duration were delivered. Filter settings were 10–5000 Hz. Distances were measured with a flexible tape