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Neurophysiological localisation of ulnar neuropathy at the elbow: Validation of diagnostic criteria developed by a taskforce of the Danish Society of clinical neurophysiology

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HIGHLIGHTS

- Danish criteria for ulnar neuropathy at elbow (UNE) have high specificity (98.4%) and positive predictive value (95.2%).
- Specificity for UNE is higher in the Danish criteria compared to the AANEM criteria.
- Danish criteria for UNE are Z-score based and thus useful across centres and clinical settings.

ABSTRACT

Objective: This study validates consensus criteria for localisation of ulnar neuropathy at elbow (UNE) developed by a taskforce of the Danish Society of Clinical Neurophysiology and compares them to the existing criteria from the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM). The Danish criteria are based on combinations of conduction slowing in the segments of the elbow and forearm expressed in Z-scores, and difference between the segments in m/s. Examining fibres to several muscles and sensory fibres can increase the certainty of the localisation.
Methods: Diagnostic accuracy for UNE was evaluated on 181 neurophysiological studies of the ulnar nerve from 171 peer-reviewed patients from a mixed patient-group. The diagnostic reference standard was the consensus diagnosis based on all available clinical, laboratory, and electrodiagnostic information reached by a group of experienced Danish neurophysiologists.
Results: The Danish criteria had high specificity (98.4%) and positive predictive value (PPV) (95.2%) and fair sensitivity (76.9%). Compared to the AANEM criteria, the Danish criteria had higher specificity ($p < 0.001$) and lower sensitivity ($p = 0.02$).
Conclusions: The Danish consensus criteria for UNE are very specific and have high PPV.
Significance: The Danish criteria for UNE are reliable and well suited for use in different centres as they are based on Z-scores.

1. Introduction

Ulnar neuropathy at the elbow (UNE) is the most common peripheral mononeuropathy after carpal tunnel syndrome (CTS) with reported incidences for UNE of 25.2–32.7.and 17.2–18.9 per 100.000 men and women, respectively (Latinovic et al., 2006; Mondelli et al., 2005).

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UNE typically presents with sensory symptoms of numbness or paresthesias in the ulnar nerve distribution as the initial complaints. Motor symptoms are less common than sensory, and range from mild weakness of intrinsic hand muscles to severe wasting and "claw hand" deformity (Bradshaw and Shefner, 1999; Campbell, 1997; Doherty, 2017). Although the clinical diagnosis can be straightforward, it may also be challenging due to selective fascicular involvement of the motor and sensory nerve fibres and presence of co-morbid conditions such as CTS, polyneuropathy, or referred pain from musculoskeletal problems. In addition, ulnar lesion at the upper arm, root or plexus lesions, or motor neuron disorders can mimic UNE (Doherty, 2017; Posner, 1998).

Accurate diagnosis of UNE is important for treatment strategies and prognosis, and to avoid unnecessary surgery. Electrodiagnostic testing is a standard part of the evaluation of ulnar neuropathy, even in seemingly straightforward cases, as the examination is important for confirming the diagnosis and for differential diagnosis (AAEM and Campbell, 1999; Werner, 2013). In the examination of the ulnar nerve for identifying and localising affection at the elbow, motor nerve conduction studies (NCS) with recording in the abductor digiti minimi (ADM), first dorsal interosseous (FDI), and adductor pollicis (AP) muscles can be performed. Sensory NCS across the elbow can additionally be performed using near-nerve needle technique (Payan, 1969; Odabasi et al., 1999). The American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) published in 1999 a practice parameter for UNE and proposed a set of diagnostic criteria, which were based on a literature review of 13 articles (AAEM and Campbell, 1999). There are no other published electrodiagnostic consensus criteria for diagnosis of UNE and to our best knowledge the criteria from AANEM have never been formally validated.

In this report we present a novel set of criteria for neurophysiological localisation of UNE developed by a taskforce of the Danish Society of Clinical Neurophysiology. The criteria have been used in the clinical practice in most neurophysiological departments in Denmark for several years and may be of value for the International neurophysiological community. The criteria were in accordance with the STARD criteria (Bossuyt et al., 2015) validated against a diagnostic reference standard obtained from a national Danish database, and furthermore compared to the criteria from AANEM.

2. Methods

2.1. Diagnostic reference standard

The consensus diagnosis of 181 ulnar nerves from 171 patients given by a group of experienced neurophysiologists served as diagnostic reference standard. These represented all patients in a Danish multicentre database with (1) NCS of the ulnar nerve across the elbow, and (2) consensus on the diagnosis. The consensus diagnoses were based on all available clinical, laboratory, and electrodiagnostic information and was not rigorously built on the Danish criteria for UNE.

The UNE-positive control group consisted of 52 patients (53 ulnar nerves) with a consensus diagnosis of localised UNE. Nine of these had additional consensus diagnoses of CTS (4), polyneuropathy (3), anterior horn cell disorder (1), or cervical radiculopathy (1). The UNE-negative group consisted of the remaining 119 patients (128 ulnar nerves), in whom 58 showed no abnormality, 16 had a non-localised lesion of the ulnar nerve (18 ulnar nerves), and 45 had other diagnoses. The mean age of the patients was 49.1 years (SD 16.0; range 13–85) and there were 86 women and 95 men. They were referred to neurophysiological examination for ulnar nerve affection (100), plexus/root lesion (21), polyneuropathy (17), motor neuron disease (13), nerve affection in upper extremity, including CTS (16), myopathy (2), dystonia (1), and meralgia paresthetica (1).

2.1.1. Multicenter database and peer review

The data used as diagnostic reference standard were extracted from the "Danish database for electrodiagnostic examination of patients with neuromuscular disorders", a collaboration among all major Danish neurophysiological departments established in 2001 and now comprising more than 800 peer-reviewed examinations of patients with mixed disorders.

In the collaboration the participating centres collect and share random samples of their neurophysiological examinations in a PHP-MySQL web database with a standardised format for electrodiagnostic data (electromyography (EMG) and NCS), and a semi-standardised format for clinical, imaging, and laboratory test information etc. (Johnsen et al., 1994; Pugdahl et al., 2009). Only examinations performed by certified neurophysiologists or neurophysiology residents under supervision are included in the database. Prior to the electrodiagnostic tests these examinations start with a detailed neurological investigation to target the electrodiagnostic tests, while the further diagnostic strategy is dependent on the test results during the examination (Fuglsang-Frederiksen et al., 1999).

The peer-review process is adapted from the European multicentre project ESTEEM as previously described (Finnerup et al., 1998; Pugdahl et al., 2005). In short, all electrodiagnostic and clinical data for an examination is entered in the database by the examiner. The examination is then disclosed to all group members for their own diagnosis selected from a pre-defined, standardised list, blinded to the original diagnosis. In case of disagreement the examination is further discussed at regular meetings to obtain consensus on the diagnosis. The database now comprises peer-reviewed examinations of more than 800 patients of mixed disorders, each with a consensus diagnoses based on clinical and neurophysiological data.

2.1.2. Electrodiagnostic examination

Electrodiagnostic recordings were done according to the routine at each participating centre as previously described (Stålberg and Falck, 1993; Trojaborg, 1992; Falck et al., 1994; Johnsen et al., 2006). Recordings of the ulnar nerve was done with the elbow in a slight to moderately flexed position with an angle of 20–60°, the measuring distance across the elbow was 10–11 cm, and temperature measured at the recording site was maintained at or above 34 °C.

In the 181 ulnar nerves with examination across the elbow, motor recording in the ADM muscle was done in all. Additional motor recording were done in 107 nerves to either the AP (65 recordings) or FDI (40 recordings) muscle, or both (2 recordings). Sensory near-nerve needle recording across the elbow was done in 57 nerves. The different combinations of recordings across the elbow are shown in Table 1. In addition, distal antidromic sensory recording of the ulnar nerve from wrist to digit 5 was done in 56 patients.

The patients were examined according to the departments' routine strategy for the condition suspected from the referral letter and findings at the initial clinical examination. The strategy could be changed according to the results obtained during the electrodiagnostic testing. This has sometimes resulted in the fact that no ulnar sensory nerve was examined.

Nerve conduction studies of one or more nerves in addition to the ulnar nerve were done in 119 patients (69.6%). In these, the median nerve was examined in 107 (32.7% abnormal), the radial nerve in 30 (13.3% abnormal), the sural nerve in 37 (56.8% abnor-