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Journal of the Neurological Sciences 271 (2008) 75 – 79

Journal of the Neurological Sciences

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Rapid ultrasonographic diagnosis of radial entrapment neuropathy at the spiral groove

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Received 15 February 2008; received in revised form 20 March 2008; accepted 27 March 2008
Available online 12 May 2008

Abstract

Background: Entrapment neuropathy of the radial nerve at the spiral groove region is relatively common. However, its localization may be technically challenging.
Objective: To evaluate the use of ultrasound (US), in relation to electrophysiological testing, for this purpose.
Methods: We studied 32 normal controls to obtain US parameters of the radial nerve. In addition, 10 patients with suspected radial neuropathy were tested using US and electrophysiological techniques.
Results: US examination correctly identified all 6 patients with radial neuropathy. The other 4 patients with alternate diagnoses did not show US abnormalities exceeding that of normal controls. US examination required a significantly shorter time than electrophysiological testing.
Conclusions: US is of value as a rapid diagnostic adjunct for the localization of radial nerve entrapment.

Keywords: Radial nerve; Radial neuropathy; Ultrasound; Nerve conduction study; Electromyography; Entrapment

1. Introduction

Entrapment neuropathy of the radial nerve most commonly occurs at the mid-humeral region, where the nerve traverses the spiral groove. Nerve injury may be caused by humeral shaft fracture [1], but direct pressure is also known to result in nerve dysfunction ('Saturday night palsy') [2]. This is usually caused by lying or sleeping on the outstretched arm, occasionally under the influence of alcohol. Other rare causes described include repetitive arm exercises [3] and manual work [4].

Radial neuropathy at the humeral region is potentially reversible, but some cases do not recover completely [5]. The electrodiagnostic localization is dependent on demonstration of conduction block across the site of involvement [6], using nerve conduction studies (NCS). However, this may not be present in all cases. In one large series, conduction block was demonstrable only in 33% of 91 cases [7]. Segmental demyelination, axonal damage or both processes may be present. In cases of severe axon loss, demonstration of conduction block or reduction of conduction velocity would be difficult. It is also known that differing degrees of damage to individual nerve fascicles may occur [8], rendering findings of NCS and electromyography (EMG) variable for individual cases.

High-resolution ultrasonography (US) may be a potential diagnostic tool in this respect. Usage of US is of proven efficacy for carpal tunnel syndrome, ulnar neuropathy and femoral neuropathy [9]. It is a quick safe, painless, and inexpensive procedure. US has the added capability of

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doi:10.1016/j.jns.2008.03.014

demonstrating structural lesions along the course of the affected nerve. The superficial location of the radial nerve at the spiral groove region provides an anatomical advantage for US diagnosis, which is evaluated prospectively in this study.

2. Methods

With ethical committee approval, we studied 32 healthy control subjects (16 men, mean age: 49, range: 22 to 78), who do not have histories of diabetes mellitus, renal impairment, cervical radiculopathy or other confounding neurological conditions. The age distribution (number of subjects) included: 20 to 29 (5), 30 to 39 (6), 40 to 49 (5), 50 to 59 (5), 60 to 69 (5) and 70 to 79 (6).

Over a 1-year period, 10 patients who presented with unilateral wristdrop or weakness in the radial distribution, but well otherwise, were evaluated. All controls and patients had US of the radial nerve performed, as well as electrodiagnostic studies with a Medtronic (Medtronic Inc, Skovlunde, Denmark) Keypoint EMG machine.

Routine nerve conduction studies (NCS) included median, ulnar, superficial radial sensory and radial motor studies [10].

For superficial radial sensory studies, the active recording electrode was placed over the 'anatomical snuffbox' region at the extensor pollicis longus tendon. The reference electrode was placed over the metacarpal head of the index finger. Antidromic stimulation was applied at the lateral border of the radius 12 cm proximal to the active recording electrode.

For radial motor studies, extensor indicis surface recordings were obtained from stimulating at mid-forearm, 4 cm above the lateral humeral epicondyle and mid upper arm above spiral groove, using a 0.5 ms square-wave pulse. The muscle was palpated to ascertain the active recording electrode position, with the reference placed 3 cm distally. Conduction block was defined as 50% drop in compound muscle action potential (CMAP) amplitude across proximal and distal sites. Comparison was made with the opposite side for absolute CMAP amplitudes. A 50% reduction in amplitude was defined as an axon loss lesion in the affected side.

We utilized Medtronic 9013S0241 adhesive surface recording electrodes (Medtronic, Skovlunde, Denmark) for all NCS. For surface stimulation, a Dantec hand-held bipolar electrode (Dantec, Skovlunde, Denmark) was employed. Surface skin temperature was maintained at 32 to 34 °C. Subjects lay comfortably supine in a quiet room.

For motor studies, the onset latency and baseline to negative peak amplitude of CMAPs were measured. For sensory studies, onset latency and peak to peak amplitudes were included for comparisons.

In all patients, the first dorsal interosseous, extensor digitorium communis, brachioaradialis and triceps muscles were sampled. For NCS, filters were set at 5 Hz to 5 kHz. For electromyography (EMG), filter settings were set at 20 Hz to 10 kHz.

US examination was conducted with a General Electric Logiq 7 Pro (GE Company, USA) machine, employing a 5 to 10 MHz linear array transducer by an experienced staff. Care was taken not to excessively compress the imaged site. With the subject in a supine position, the radial nerve can be identified at the posterolateral aspect of the humeral shaft, alongside the brachial artery demonstrable with Doppler US. Measurements were obtained at the middle third of the humerus, where the nerve appears as an oval structure on the transverse scan in close relation to the bone. The normal nerve in this plane has a speckled appearance and is relatively hyperechoic compared with surrounding muscle. In the longitudinal plane, it exhibits a linear fascicular appearance. In contrast, the abnormal radial nerve is often swollen, with loss a uniform hypoechoic appearance and loss fascicular pattern [11,12]. We measured the longest transverse length (i.e. longest diameter in the transverse scan), longest transverse breadth (perpendicular to transverse length), ratio of these 2 parameters (breadth/length), longitudinal diameter (width in the longitudinal plane), as well as cross-sectional area (area in the transverse scan). Visual estimation of increased or decreased nerve echogenicity was also recorded.

For the purposes of comparison, the gold standard of diagnosing radial neuropathy was taken as combination of clinical features, imaging and EMG, as some cases had other diagnoses other than radial entrapment.

Data was analyzed using SPSS for Windows Version 10.1. Student's *t*-test and Pearson's correlation tests were employed for statistical calculations. The upper limit of normality was at 2 standard deviations (SD) above the mean. A p value <0.05 was considered statistically significant.

A separate investigator recorded the time taken to perform US examination of both sides, as well as time duration to complete NCS and EMG studies.

3. Results

All controls and patients were cooperative and tolerated the procedures well. US examination provided information required without any technical difficulty.

3.1. Normal controls

For superficial radial sensory controls, the mean and standard deviation (SD) of amplitude and conduction velocity were 28.12 [9] μV and 25 (6.89) m/s respectively. Hence, the lower limits of normal at 2 SDs were 10.12 μV and 46.5 m/s.

Based on our laboratory controls, the mean radial motor amplitude was 9.5 (2.5) mV. This corresponded to a lower limit of normality at 4.5 mV.

The US data in healthy controls were normally distributed Shapiro–Wilk test, $p>0.05$ for all). Normal values for US in