Clinical Neurophysiology 117 (2006) 2446–2450

www.elsevier.com/locate/clinph

The long thoracic nerve conduction study revisited in 2006

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Accepted 15 July 2006
Available online 25 September 2006

Abstract

Objective: To compare the reliability and feasibility of recording long thoracic nerve (LTN) conductions either with surface or needle electrodes.

Methods: The nerve conduction studies were carried out bilaterally on 40 control subjects. The LTN was first stimulated at the axilla and recorded with surface electrodes located on the 7th or 8th digitations of the serratus anterior (SA), then stimulated at Erb's point and recorded with a needle inserted in the 6th or 7th digitations of the SA. For each method, the latency and amplitude of the motor action potential were recorded.

Results: Responses were recorded on both sides for each patient. With surface recording, the mean latency was 2.2 ± 0.30 ms, and the mean amplitude was 5.3 ± 2.4 mV. With needle recording, the mean latency was 3.65 ± 0.45 ms, and the mean amplitude was 8.95 ± 4 mV.

Conclusions: This study demonstrates that both techniques are reliable, feasible, and correlate well.

Significance: Our study shows surface recording of nerve conduction should be favored because it is non-traumatic, less uncomfortable for the patient, and less prone to pitfalls. Nevertheless, in pathological cases, both techniques should be used at initial and follow-up examinations in order to better assess axonal loss and nerve conduction impairment.

Keywords: Long thoracic nerve; Nerve conduction; Electrodiagnosis; Serratus anterior muscle; Nerve compression; Parsonage and Turner syndrome

1. Introduction

Long thoracic nerve (LTN) lesions are clinically underrecognized by general practitioners and specialists except rheumatologists, orthopedists, sports physicians, neurologists, and neurophysiologists. On the opposite, these specialists sometimes over-diagnose LTN lesion when faced with mild cases of winging scapula (Friedenberg et al., 2002; Gregg et al., 1979; Kauppila and Vastamaki, 1996; Patel and Nelson, 1996). Because LTN conduction study and serratus anterior needle examination are not routinely used and are somewhat difficult to perform, there is need for a feasible and reliable method to study the LTN. We carried out this prospective study in order to compare the reliability and feasibility of LTN conduction recording performed either with surface electrodes or with needle electrodes, and to provide normative data for both methods when they are performed in one single laboratory.

1.1. Anatomy

The LTN arises directly from motor fibers from nerve roots C5, C6, and C7. It descends the neck and the thoracic wall (Depalma et al., 2005; Kaplan, 1980; Pitres and Testut, 1925). It is a "pure motor" nerve which innervates the 11 digitations of the serratus anterior muscle along the axillary line.

2. Materials and methods

We conducted prospectively LTN bilateral examination of 44 control subjects, consisting of 18 females and 26 males, aged from 14 to 71 years (mean 35.3 years). No sub-

Abbreviations: LTN, long thoracic nerve; SA, serratus anterior muscle; CMAP, compound motor action potential.

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doi:10.1016/j.clinph.2006.07.308

jects had winging scapula, and SA muscle strength was always noted 5/5 on the Medical Research Council (MRC) scale: all patients could perform push-ups with no sign of winged scapula. All subjects were referred for neurophysiological assessment of the shoulder because of pain or motor weakness related to other causes than LTN lesion. The motives for referral were either nerve lesions (10 cases of single cervical root disease, 4 cases of suprascapular nerve lesion, and 3 cases of accessory nerve lesion), or shoulder pain with normal neurological and electrodiagnostic findings which were ultimately related to various causes (12 cases of fibromyalgia, 9 cases of rotator cuff lesion, 4 cases of shoulder or acromio-clavicular disjunction, and 2 cases of frozen shoulder). Naturally, all patients had normal strength of the SA (5/5 MRC), which was best attested by asking the patient to perform push-ups.

All patients underwent standard electrodiagnosis of the upper limb including needle examination on C5 to C8 muscles in the symptomatic limbs, and unilateral median and ulnar nerve conduction studies in order to exclude patients with polyneuropathies. In addition, every patient underwent needle examination of the infraspinatus, upper trapezius, and serratus anterior muscles in the symptomatic limb with bilateral suprascapular, accessory, and long thoracic nerve conduction studies. Skin temperature was measured, and hands were warmed prior to testing for temperatures below 32 °C. Statistical analysis was performed using means, standard deviations, and Student's *t*-tests; a value of $p < 0.05$ was considered significant. For each control subject, the LTN was studied using two different methods, because specifically recording the serratus anterior muscle (SA) requires a different recording method when stimulation is done at Erb's point or at the axilla (see Section 4). All controls provided informed consent prior to the examination.

2.1. Surface recording technique (Depalma et al., 2005; Seror, 2005) (Fig. 1)

The long thoracic nerve was stimulated at the axilla with a fixed distance electrode (25 mm), and the arm fully abducted. Stimulation intensity varied from 40 to 100 mA, stimulus duration was 200 μs. Amplification was 2 or 5 mV per division. The monopolar recording was performed with self-adhesive, single use, surface electrodes measuring 15 by 18 mm. The active electrode was fixed on the 7th or 8th digitation of the SA anterior to the latissimus dorsi, the reference electrode was fixed at the tip of the sternum, between the nipples (C: cathode or active electrode; a: anode or reference electrode), and the ground electrode was placed on one upper forearm. Latency was measured at onset of the negative wave of the compound motor action potential (CMAP), and amplitude was measured from baseline to peak of the negative wave.

2.2. Needle recording technique (Alfonsi et al., 1986; Petrera and Trojaborg, 1984; Seror, 2005) (Fig. 2)

The upper brachial plexus was stimulated at Erb's point with a fixed distance electrode (25 mm) (monopolar stimulation was never required in this study). The stimulation intensity varied from 40 to 100 mA, and stimulus duration was usually 200 μs. Amplification was 1 or 2 mV per division. Motor action potential was recorded with a disposable, monofilar, concentric needle electrode inserted in the 6th or 7th digitation of the SA, and the ground electrode was placed on one upper forearm. Latency was measured at onset of the first negative or positive deflection of the motor action potential (MAP), and amplitude was measured from peak to peak. The MAP's shortest latency and highest amplitude of 3 supramaximal stimulations were analyzed to establish normative data.

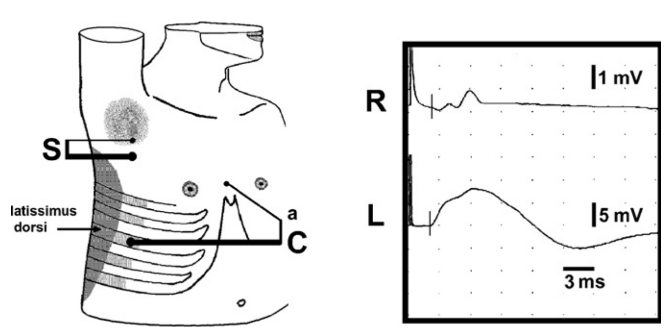

Fig. 1. Surface recording technique after axilla stimulation. LTN surface recording of the right side performed 5 days after pain onset was abnormal in this patient: the latency was 2.3 ms and the amplitude 0.7 mV on the right side vs 2.3 ms and 7.9 mV, respectively, on the left side. Amplitude is measured from baseline to negative peak. C: cathode or active electrode; a: anode or reference electrode.

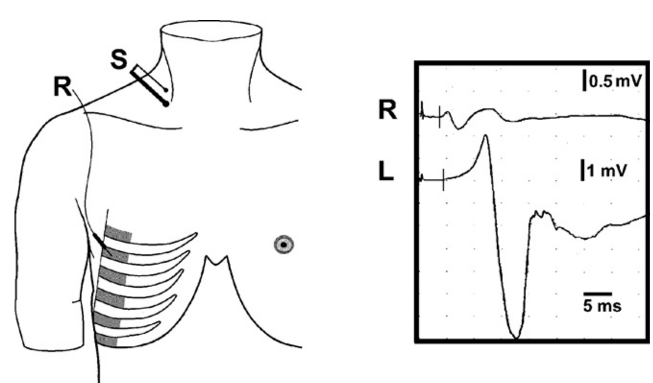

Fig. 2. Needle recording technique after Erb's point stimulation. LTN concentric needle recording of the right side in the same patient was also abnormal: the latency was 4.2 ms and the amplitude 0.5 mV on right side vs 4.6 ms and 8 mV, respectively, on the left side. Amplitude is measured from peak to peak.