Clinical Neurophysiology Practice 1 (2016) 18–25

Contents lists available at ScienceDirect

Clinical Neurophysiology Practice

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

Review article

Antidromic vs orthodromic sensory median nerve conduction studies

Josep Valls-Sole *, Joao Leote, Pedro Pereira

EMG Unit, Neurology Department, Hospital Clinic, Barcelona, Spain
IDIBAPS (Institut d'Investigació Augustí Pi i Sunyer), Facultat de Medicina, University of Barcelona, Barcelona, Spain

A R T I C L E I N F O

Article history:
Received 4 February 2016
Accepted 10 February 2016
Available online 7 April 2016

Keywords:
Sensory nerve action potential
Antidromic nerve conduction test
Orthodromic nerve conduction test
Carpal tunnel syndrome

A B S T R A C T

Objective: Median sensory nerve conduction studies are arguably the most often performed electrodiagnostic tests worldwide. Routine tests in clinical practice are done using either antidromic or orthodromic techniques type of stimulation, with no universal agreement on the use of one or the other technique.
Methods: We review the advantages and drawbacks of antidromic and orthodromic as well as their particularities for clinical application and research.
Results: The two techniques differ on how physical and physiological changes affect the action potential. Near-nerve recording is better suited for the orthodromic than for the antidromic technique, while studies of nerve excitability are better suited for the antidromic than for the orthodromic technique.
Conclusion: Both techniques are equally suitable for routine tests but research studies may specifically demand one or the other.

Contents

1. Introduction

Sensory nerves of the hand are commonly examined in routine practice of electrodiagnostic testing. The study of median and ulnar nerves is not only useful for the diagnosis of entrapment neuropathies but also for the assessment of suspected polyneuropathy, plexopathy or radiculopathy as well as for physiological studies in healthy subjects. The most frequent request for electrodiagnostic assessment of sensory nerve conduction in the finger-to-wrist segment of human hands is undoubtedly carpal tunnel syndrome (CTS). Many of us have begun to practice electrodiagnostic testing by determining median nerve conduction in healthy subjects and patients with CTS. Still, even if it is one of the most studied syndromes in neurology, our knowledge of its pathophysiology and of the correlation between neurophysiological testing and clinical aspects is incomplete (Werner and Andary, 2002). The neurophysiological study of CTS is not fully standardized but, instead, many

* Corresponding author at: Neurology Department, EMG, Neuropathic Pain and Motor Control Unit, Hospital Clínic, Villarroel, 170, Barcelona 08036, Spain. Tel.: +34 932275413; fax: +34 932275783.

E-mail address: jvalls@clinic.ub.es (J. Valls-Sole).

http://dx.doi.org/10.1016/j.cnp.2016.02.004
2467-981X/

methods have been described and are being used without consensus. To begin with, there is no universal agreement on whether to use antidromic or orthodromic techniques and no advice on that matter has been issued in various guidelines published so far (Jablecki et al., 2002; Sandin et al., 2010; Basiri and Katirji, 2015).

Orthodromic testing of sensory nerves has a long history. Dawson and Scott (1949) were the first to show that it was possible to record sensory nerve action potentials through the skin. Later on, Dawson (1956) used for the first time ring finger electrodes to obtain the orthodromic sensory nerve action potential (SNAP) in proximal nerve segments. Gilliatt and Sears (1958) were the first to use the method for clinical purposes in patients with entrapment syndromes and polyneuropathies. Antidromic testing was first described by Sears in 1959, as quoted in papers in which the authors used the antidromic technique to examine a large number of patients with suspected carpal tunnel syndrome (Campbell, 1962) or a single patient with polyneuritis (Bannister and Sears, 1962).

Each of the two techniques has its advantages and drawbacks but clinical neurophysiologists favor either one or the other. In an unofficial poll among physicians and technicians in Barcelona (Spain) and Lisbon (Portugal), we found that, in most occasions, the choice of one or another technique depended mainly on the school and training experience or convention than in theoretically based arguments, even though most people preferred the antidromic technique, considered to be easier to perform. Confidence in the results of an examination depends largely on technical ability, knowledge of the methodological variants and recognition of possible pitfalls and errors intrinsic of a specific technique. Therefore, we thought to review the advantages and drawbacks of orthodromic and antidromic testing of sensory nerve fibers over the finger-to-wrist segment of the median nerve for the practitioners to have material to choose from when deciding which technique suits their purposes better.

2. Technical aspects

Clinical neurophysiological assessment of hand sensory nerves is rapidly performed many times a day in most electrodiagnostic centers around the world. It is one of the easiest nerve conduction studies to perform and it is commonly the first technique for beginners to learn. Once the machine is set and the patient is in a quiet and comfortable environment, it takes only a few minutes to perform suitable antidromic or orthodromic recordings from one nerve that would serve the purposes of the study.

The examiner should be aware of the changes in waveforms, latency and amplitude that relate to the position of the electrodes and be consistent with the setup chosen for clinical work. Most authors would agree in keeping a standardized distance between the stimulating cathode and the recording active electrode of 14 cm in normal sized hands. It is also generally accepted that the study of short segments of the nerve across the site of compression increases the sensitivity of the study (Jablecki et al., 2002). In fact, one of the most sensitive tests recommended for the assessment of compression of the median nerve at the wrist is stimulation at the palm and recording over the wrist at a distance of 8 cm (Jablecki et al., 2002; Sandin et al., 2010).

The SNAP, obtained with whatever technique, is measured according to the conventional parameters of latency and amplitude. Duration is less commonly reported in clinical studies, possibly because of the difficulties in determining the true end of the SNAP. In fact, the analysis of duration reveals not only the eventual dispersion of the volley but also interesting physiological aspects related to the recording site. In a bipolar recording, the SNAP results from the summation of the activity reaching both electrodes and, therefore, inter-electrode distance significantly affects the SNAP waveform. Onset latency, usually measured at the beginning of the negative phase, depends on the fastest conducting fibers, while peak latency is an expression of the mean conduction velocity value among all fibers participating in the SNAP. No significant differences in diagnostic yield have been reported for conduction velocity calculated after onset or peak latency (Kasius et al., 2014). However, Pyun et al. (2005) have drawn attention to the fact that onset latencies may give more false positive results than peak latency measurement with both orthodromic and antidromic techniques. Amplitude can be measured from baseline to the peak (negative phase) or peak to peak (including negative and positive phases).

2.1. Antidromic technique

For this, the stimulating electrode activates the median nerve at the wrist and the response is recorded over digital nerves of the index or middle fingers. The stimulating electrodes should be placed longitudinally over the median nerve, to avoid unintended concomitant activation of the ulnar or radial nerves in transversally oriented stimuli. Typically, the cathode is placed distal with respect to the anode, even though no anodal block occurs with stimuli of high intensity (Dreyer et al., 1993). The exact distance between cathode and anode is not usually considered an important factor with antidromic stimulation because a response to cathodal stimulation can be obtained similarly using monopolar and bipolar montages. However, the inter-electrode distance is very important at the recording side (Wee and Ashley, 1990). This aspect is discussed more thoroughly below.

Supramaximal intensities used for the stimulation of sensory fibers at wrist level will unavoidably also activate motor fibers and, therefore, generate movements because of contraction of hand muscles (lumbricalis and thenar muscles). These movements may cause some interference with the recording and it may be adequate to hold tight the patient's hand when recording, mostly if there is any clinically based suspicion that the action potentials will be of small amplitude. A single stimulus is usually enough to obtain a sizeable action potential. However, it is good practice to average at least 8 or 10 epochs time-locked to the stimulus to smooth the waveform for an easier measuring of amplitude and latency.

2.2. Orthodromic technique

Stimulating electrodes are usually ring electrodes placed around the proximal and middle phalanxes of the 2nd or 3rd digits and the recording electrodes are placed on the ventral aspect of the wrist, over the median nerve, usually at about 1–2 cm proximal to the proximal wrist crease. For the stimulation, the electrodes do not need any special preparation but the characteristics of the stimulus are important.

For recording, as with the antidromic technique, it is recommendable to use a fixed distance between the active and reference recording electrodes to avoid electrode-related changes in SNAP amplitude and duration. For this purpose, wet pad electrodes mounted on a plastic case and attached with a Velcro strap or held manually over the nerve are a good option because the inter-electrode distance is already set and they can be slightly repositioned to get the largest response amplitude. Obviously, other types of electrodes would yield equally good results provided they are consistently used in any study requiring comparison among subjects. The orthodromic SNAP is of smaller amplitude than the antidromic one and its amplitude but not its latency is affected by wrist size (Lim et al., 1995). However, this is apparently also the case with antidromic recording, where amplitude of the finger