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Effects of Elbow Position on Motor Conduction Velocity of the Ulnar Nerve

ROGER M. NELSON, MS

The purpose of this study was to evaluate the ability of the ulnar nerve motor axons to conduct an evoked action potential at three elbow positions (0°, 90°, and 120°). The latency (from above and below elbow), negative-phase amplitude, and duration of the evoked action potential were used to evaluate the effect of elbow position on 50 normal men. The results indicate that latency of the response, negative-phase amplitude, and duration of the evoked action potential did not vary with the elbow position. Clinical implications for the performance of motor nerve conduction studies for the ulnar nerve are presented. Suggestions for arm position during the motor nerve conduction studies are included.

Key Words: Electromyography, Ulnar nerve.

Entrapment of the ulnar nerve at the elbow is often called “tardy ulnar palsy.” This condition is evaluated, in part, by calculating motor nerve conduction velocity (MNCV) across the elbow segment. Slowing of velocity by at least 10 m/sec in the across-the-elbow segment, as compared to the velocity of the above-the-elbow segment, is considered clinically significant. At present the position of the elbow during the test has not been standardized. Although illustrations in books on electrophysiology refer to sites of stimulation for the ulnar nerve with a fully extended elbow, the texts do not explain why the elbow is pictured that way. Books do not refer to the possible effect that the elbow position might have on the conduction capabilities of the ulnar nerve. The position of the elbow, however, appears to influence the conduction velocity of the motor axons of the ulnar nerve; MNCV of the ulnar nerve has been found to be slow when the elbow is in full extension.

Various explanations have been offered for the phenomenon of diminished across-elbow velocities when the elbow is fully extended. For example, error in measuring the nerve length as it passes through the ulnar groove may be a factor. The ulnar nerve has considerable slack when the elbow is fully extended, such that the nerve may even assume an undulant course. If the length of the ulnar nerve across the fully extended elbow is estimated by surface measurement, the measured length will be less than the true length. Such an error can lead to incorrect computation of conduction velocity.

When the elbow is in midflexion (70–90°), the MNCV becomes more consistent with the other segments of the ulnar nerve. Thus, a position of elbow flexion might seem to be best for evaluating MNCV of the ulnar nerve across the elbow. Several investigators, however, have suggested that elbow flexion can induce stretch or compression of the ulnar nerve. Thus the assessment of the MNCV of the ulnar nerve might not be accurate with the elbow in flexion. Because of this paradox, this study was undertaken to find the optimal elbow position for determining ulnar MNCV across the elbow. To achieve this purpose, the latency of a muscle action potential (MAP) evoked by supramaximal stimulation of the ulnar nerve above the elbow and the specific characteristics of the evoked action potential were studied with the elbow in three different positions.

Unlike conduction velocity, latency is not dependent on surface distance measurement. If a pressure block or stretch of the ulnar nerve does not occur with elbow flexion, the proximal (above-elbow) stimulation latency of an evoked MAP should be the same regardless of elbow position. If a pressure block or stretch of the nerve is induced by elbow flexion, however, proximal stimulation latency of an evoked MAP should increase. The distal (below-elbow)
METHOD

Fifty men between 17 and 39 years of age (mean 26.3 years) served as subjects. None of the subjects had peripheral nerve dysfunction or metabolic disorders or were currently using drugs known to affect nerve conduction.

Each subject lay supine with a pillow under his head for comfort. The right arm was arbitrarily chosen as the limb to examine, inasmuch as no significant difference in MNCV exists between dominant and nondominant limbs.10,16

The borders of the abductor digit minimi muscle were located by palpation when the subject forcefully abducted the little finger against resistance. The recording electrodes were surface disks mounted in a plastic bar so the intraelectrode distances were constant (3 cm from center to center) for all subjects.

After the overlying skin was cleaned the active electrode was placed over the center of the muscle belly. The inactive electrode lay over the tendon at the metacarpophalangeal joint. The ground electrode was placed on the dorsum of the wrist over the ulnar styloid process.

The subject's arm was positioned in slight flexion (10–15°) and a mark was made on the skin 4 cm above and 4 cm below the medial epicondyle, approximating the path of the ulnar nerve. These marks served as the sites of electrostimulation. The tests were performed with the elbow in three different angles of elbow flexion (0°, 90°, and 120°).17 Below-elbow stimulation was done and evoked MAPs reported for each angle of flexion in order to provide a basis for comparison and to maintain consistency within the experiment.

A standard clinical EMG TECA model TE-4* was used to stimulate the nerve and to amplify and record the evoked MAPs. The differential amplifier had a frequency response between 200 Hz and 10,000 Hz. A high gain was used to amplify the evoked MAP in

* TECA Corp, 3 Campus Dr, Pleasantville, NY 10570.
order to increase the accuracy of measurement of the amplitude of the negative phase of the MAP, which was displayed on the oscilloscope. Permanent records were made by a fiber optic recording system. The subject's nerve was stimulated with a 0.1-msec square-wave pulse at an amplitude that evoked a maximal MAP. The stimulating electrodes were bipolar and 3 cm apart (center to center).

The nerve was stimulated at the two sites described above for each of the three angles of flexion. The following characteristics of the evoked MAP were measured:
1. Latency (msec) from the stimulus artifact to the initial negative deflection of the evoked MAP (Figure).
2. Negative-phase duration (msec) from the initial negative deflection to the point on the isoelectric base-line at which the wave first crosses (Figure).
3. Negative-phase amplitude (mv) from the isoelectric base-line to the top of the negative phase (Figure).

RESULTS

The means, standard deviations, and ranges of the latency for the evoked MAP for both above-elbow and below-elbow stimulation are shown in Table 1. Below-elbow latency values displayed very little variation and served as a reliability check for the experimental procedure.

The latency of the MAP evoked by above-elbow stimulation did not vary appreciably at the different positions of the elbow. The duration and amplitude of the evoked MAP from above-elbow and below-elbow stimulation in the three elbow positions is presented in Table 2. There was little or no variation in amplitude or duration of the evoked MAP resulting from the stimulation of the nerve below the elbow, again providing a reliability check for the procedure.

No appreciable variation occurred in the amplitude or duration of the evoked MAP with above-elbow stimulation.

DISCUSSION

The results of this study suggest that the slow ulnar MNCV reported with elbow extension could be caused by errors in measuring the length of the ulnar nerve. In addition, stretch or compression of the ulnar nerve does not appear to be an important factor influencing the conduction of motor axons when the elbow is in flexion.

Two variables are used to calculate MNCV: latency measures and distance measurements between the two sites of nerve stimulation. In this study, latency of an evoked MAP with above-elbow and below-elbow stimulation was unaffected by elbow position. Thus, the discrepancy in the reported conduction velocity of the ulnar nerve when the elbow is in extension may be caused by errors in distance measurement.

In this study the latency measures suggest that the nerve fibers were probably not blocked (by compression or stretch) during elbow flexion. This conclusion is also supported by the consistency in the characteristics of the evoked MAP in all elbow positions for above-elbow stimulation. The below-elbow values in evoked MAP characteristics are all very similar to the above-elbow values.

The midposition of elbow flexion (90°) should be used when measuring MNCV of the ulnar nerve. As mentioned earlier, the straight elbow may not yield valid measurements because of the difficulty in measuring the actual length of the nerve. Assuming that surface measurements of the distance between the sites of stimulation do not portray an accurate estimate of true distance, calculated velocities will be in error. Therefore, to avoid unknown errors, the straight elbow should be avoided. The other option is to use the position of maximal flexion for the MNCV calculation. Another type of uncontrolled error might confound the results in this flexed position. The aponeurotic sheath between the two heads of the flexor carpi ulnaris muscle (that is, the cubital tunnel) may compress the ulnar nerve as it passes between them. Some individuals may exhibit more compression than others but the amount of the compression is unknown. Therefore, the maximal position of elbow flexion should also be avoided. The midposition of flexion appears to be the logical choice for MNCV determinations of across-elbow conduction velocities.
TABLE 2
Negative Phase Amplitude (N=35) and Duration (N=50) in Evoked Ulnar Motor Nerve Muscle Action Potential with the Elbow Positioned in 0, 90, and 120 Degrees of Flexion

<table>
<thead>
<tr>
<th>Site of Stimulation</th>
<th>Angle of Elbow Flexion (degrees)</th>
<th>Amplitude (mv)</th>
<th>Duration (msec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>SD</td>
</tr>
<tr>
<td>Above Elbow</td>
<td>0</td>
<td>7.12</td>
<td>1.3</td>
</tr>
<tr>
<td>Above Elbow</td>
<td>90</td>
<td>7.12</td>
<td>1.1</td>
</tr>
<tr>
<td>Above Elbow</td>
<td>120</td>
<td>7.06</td>
<td>1.2</td>
</tr>
<tr>
<td>Below Elbow</td>
<td>0</td>
<td>7.30</td>
<td>1.3</td>
</tr>
<tr>
<td>Below Elbow</td>
<td>90</td>
<td>7.12</td>
<td>1.3</td>
</tr>
<tr>
<td>Below Elbow</td>
<td>120</td>
<td>7.14</td>
<td>1.2</td>
</tr>
</tbody>
</table>

If elbow position is standardized for the performance of MNCV in all ulnar nerve segments, then future research could be devoted to collecting normative data on the velocities. In addition, the sensory component, which is often more sensitive than the motor component as an indicator of early neural involvement, could be evaluated in a normal population.18

CONCLUSIONS

Electrostimulation of the ulnar nerve in 50 normal adult men revealed that:
1. The latency of the evoked MAP did not vary appreciably as a function of elbow position.
2. The below-elbow latency values of the evoked MAP displayed little variation as a function of elbow position.
3. The characteristics of the evoked MAP did not vary as a function of elbow position.
4. The absence of alteration in motor nerve conduction as a function of elbow position appears to shift the reason for reported slow velocities across the fully extended elbow to errors in external factors (viz: measurement) and away from internal factors such as stretch or compression of the nerve.
5. The midflexion position (90°) appears to be the position from which to perform and calculate MNCV along the course of the ulnar nerve.

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