Cervical radiculopathy: diagnostic aspects and non-surgical treatment
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CHAPTER 5

Results of needle electromyography in 176 patients with cervical radiculopathy

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Submitted
Abstract

Objectives
To investigate a standardised electromyography protocol in patients with recent onset cervical radiculopathy.

Methods
For this prospective cross-sectional study we included patients with a clinical diagnosis of recent onset (less than one month) cervical radiculopathy taken from a cohort of patients participating in a clinical trial on non-surgical treatment. The electrodiagnostic consultant was blinded for the clinically suspected level of root compression, symptom duration and MRI-results. Standardised concentric needle electromyography was done in five muscles of the affected arm.

Results
176 patients were included. Abnormal spontaneous activity was found in only 16.5% of cases and neurogenic motor unit action potentials in 29.5%, yielding a total of 39.2% of abnormal EMG examinations.

Conclusion
The low percentage of EMG abnormalities demonstrates that this standardised limited EMG protocol is not useful as a routine investigation in patients with recent onset cervical radiculopathy.
Introduction

Although many studies on electromyography (EMG) in patients with cervical radiculopathy have been published \(^1\text{-}^6\) there is still no consensus on its diagnostic value. It has been advised to perform EMG in a blinded fashion to properly evaluate its value. \(^6\text{-}^7\) However we are not aware of such studies in this condition. In this explorative study we report our EMG findings in a large series of patients with a clinical diagnosis of cervical radiculopathy. In every patient we performed a standardised EMG protocol consisting of needle electrode examination of five arm muscles. The electrodiagnostic consultants were blinded for clinical and magnetic resonance imaging (MRI) data.

Methods

For this prospective cross-sectional study we included patients with a clinical diagnosis of recent onset (less than one month) cervical radiculopathy taken from a cohort of patients participating in a clinical trial on non-surgical treatment. The medical ethics committees of the participating hospitals approved the protocol. Written informed consent was obtained from all patients. Patients were examined by the local investigator (neurologist) who established a clinical diagnosis of cervical radiculopathy based on history and neurological findings on examination. Inclusion criteria for the study were: age 18 - 75 years, arm pain on a visual analogue pain scale \(\geq 40\) mm on a 0-100 scale, radiation of arm pain distal to the elbow, and at least one of the following: (1) provocation of the arm pain by neck movements, (2) sensory changes in one or more adjacent dermatomes, (3) diminished deep tendon reflexes in the affected arm, (4) muscle weakness in one or more adjacent myotomes.

Needle electrode examination

The electrodiagnostic consultant was aware of the suspicion of cervical radiculopathy but blinded for the clinically suspected level of root compression, symptom duration and MRI-results. Patients were asked not to inform the EMG consultant about their symptoms. \(^7\) At the time of the EMG, symptom duration had to be at least 3 weeks; otherwise the EMG was postponed as previously advised. \(^5\text{-}^9\) Standardised concentric needle electromyography was done on five muscles of the affected arm, representing C5, C6, C7 and C8 myotomes: m. brachioradialis (C5, C6), m. flexor carpi radialis (C6, C7), m. triceps brachii (C7), m. extensor digitorum communis (C7, C8) and m. abductor
An examined muscle was considered abnormal if abnormal spontaneous activity (fibrillations, positive sharp waves) or neurogenic motor unit action potential (MUAP) abnormalities (increased polyphasic motor units, increased motor unit amplitudes (>7mV) or high frequency motor unit recruitment) were recorded.

Analyses
We recorded the occurrence of EMG abnormalities (abnormal spontaneous activity and neurogenic MUAP abnormalities) for each examined muscle and dichotomized the overall EMG examination as normal or abnormal. The EMG was considered abnormal if EMG abnormalities occurred in one or more of the above mentioned muscles.

Results
Two hundred and five patients were included in the trial on conservative treatment. Of these, 29 were excluded from the current EMG study because they refused to undergo the procedure in advance (n=24) or they refused continuation of the EMG during the procedure (n=5). So, the number of included EMGs was 176. The mean duration of arm pain at the day the EMG was performed was 7.4 weeks (SD 2.9).

Clinical characteristics are listed in table 1. The pain in the arm (VAS score 69.6 mm) was more severe than the pain in the neck (VAS score 57.5 mm). Almost all patients had sensory disturbances (90.3%), whereas hyporeflexia and muscle weakness were present in 44.9 and 35.2%.

Table 1 – Clinical characteristics of 176 included patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (SD)</td>
<td>47.2 (10.0)</td>
</tr>
<tr>
<td>Mean (SD) VAS on arm pain (mm)*</td>
<td>69.6 (20.2)</td>
</tr>
<tr>
<td>Mean (SD) VAS on neck pain (mm)*</td>
<td>57.5 (28.5)</td>
</tr>
<tr>
<td>Provocation of arm pain by neck movements, n (%)</td>
<td>121 (68.8)</td>
</tr>
<tr>
<td>Sensory disturbances, n (%)</td>
<td>159 (90.3)</td>
</tr>
<tr>
<td>Hyporeflexia, n (%)</td>
<td>79 (44.9)</td>
</tr>
<tr>
<td>Muscle weakness, n (%)</td>
<td>62 (35.2)</td>
</tr>
</tbody>
</table>

* Visual Analogue Scale; 100 mm scale (0=no pain; 100=worst pain ever).
Needle electromyography

In 39.2% of the EMG examinations we found the predefined abnormalities (Table 2). Abnormal spontaneous activity (16.5%) was less often seen than neurogenic motor unit action potentials (29.5%). The abductor digiti minimi muscle showed the highest percentage of MUAP abnormalities.

**Table 2 – Needle electromyography abnormalities recorded from 176 patients with cervical radiculopathy**

<table>
<thead>
<tr>
<th></th>
<th>all EMG abnormalities</th>
<th>abnormal spontaneous activity</th>
<th>neurogenic MUAP abnormalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=176</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td>69 (39.2)</td>
<td>29 (16.5)</td>
<td>52 (29.5)</td>
</tr>
<tr>
<td>m brachioradialis</td>
<td>12 (6.8)</td>
<td>8 (4.5)</td>
<td>4 (2.3)</td>
</tr>
<tr>
<td>m. flexor carpi radialis</td>
<td>15 (8.5)</td>
<td>13 (7.4)</td>
<td>4 (2.3)</td>
</tr>
<tr>
<td>m. triceps brachii</td>
<td>20 (11.4)</td>
<td>6 (3.4)</td>
<td>15 (8.5)</td>
</tr>
<tr>
<td>m. extensor digitorum communis</td>
<td>25 (14.2)</td>
<td>10 (5.7)</td>
<td>17 (9.7)</td>
</tr>
<tr>
<td>m. abductor digiti minimi</td>
<td>37 (21.0)</td>
<td>8 (4.5)</td>
<td>31 (17.7)</td>
</tr>
</tbody>
</table>

In 39.2% of the EMG examinations we found the predefined abnormalities (Table 2). Abnormal spontaneous activity (16.5%) was less often seen than neurogenic motor unit action potentials (29.5%). The abductor digiti minimi muscle showed the highest percentage of MUAP abnormalities.

**Discussion**

We evaluated EMG data obtained from a standardised protocol in patients with a firm clinical diagnosis of cervical radiculopathy. Abnormal spontaneous activity, indicating active or ongoing axonal loss, was found in only 16.5% of patients, neurogenic MUAPs were seen in 29.5% of patients. As we only included recent onset cases, with a relatively benign course of the pain from whom only 6.3% needed surgery (see also chapter 6), it is not surprising that overall only 39.2% of EMGs showed abnormalities. In literature there is little discussion on the existence of false-negative EMG findings in patients with clinical evidence of cervical root compression. One explanation is that usually the sensory fibres are compromised in cervical radiculopathy. This was also the case in our cohort in which 64.8% of the 176 patients had normal strength and 55.1% had normal reflexes, whereas sensory disturbances were found in 90.2%.

For our study we used a needle electromyography screening limited to 5 muscles because we chose a program with minimal burden for this large group of patients with a good prognosis for whom the reason to perform the test was mainly scientific. Also, we
did not include examination of the paraspinal muscles for the same reason. In addition, there is ample evidence that both sensitivity and specificity are moderate. However we might have found higher percentages abnormalities if we had used a less strict study protocol in which more muscles per patient were examined. Dillingham et al studied patients with an electrodiagnostically confirmed diagnosis of cervical radiculopathy, in whom they tried to establish the optimal screening program, comparing screens consisting of 5 muscles with screens of 6, 7 or 8 muscles. When using 5 muscles without the paraspinals like in our patients they found EMG abnormalities (spontaneous muscle activity and MUAP abnormalities) in 84 to 92% of the study population, this percentage increased to 90 to 98% when paraspinals were included. The high percentages of EMG abnormalities in this study can not be compared with ours, as the inclusion of patients was based on the presence of needle electromyographic abnormalities in whom only 65% of patients reported arm pain, whereas we included patients with a clinical diagnosis of recent onset cervical radiculopathy, i.e., all had severe brachialgia.

Several other publications recommend a screening program of six to eight limb muscles representing the different myotomes, including paraspinal muscles. However none of these authors based their recommendations on prospective clinical studies. On the other hand, we may have overestimated our findings, as we considered EMG abnormalities in one muscle consistent with involvement of a cervical root, whereas the presence of two abnormal muscles in one myotome is often advised.

One of the strengths of our study is that it fulfils several criteria stated by the American Association of Electrodiagnostic Medicine (AAEM) in their review on the value of EMG in cervical radiculopathy. For instance, we had a prospective study design and made a diagnosis of cervical radiculopathy independent of the EMG results. Other strengths of our study included the large study population, well-defined inclusion criteria and blinding of the electrodiagnostic consultants.

A true gold standard for cervical radiculopathy is not available. Surgical assessment of root compression could be considered the gold standard, but only a minority of patients will undergo surgery as was also the case in our study (12 out of 205 patients). Cervical radiculopathy is primarily a clinical diagnosis. Most patients who have long lasting arm pain will have MRI of the cervical spine as the method of choice. However, we found false-positive MRI results in 45% and false-negative MRIs in almost one-quarter
of our patients. (chapter 4) Therefore we refrained from calculation of sensitivity and specificity of EMG using MRI as gold standard.

The low percentage of EMG abnormalities demonstrates that this standardised limited EMG protocol is not useful as a routine investigation in patients with recent onset cervical radiculopathy and relatively mild neurological deficit.
Chapter 5


