Cervical radiculopathy: diagnostic aspects and non-surgical treatment
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CHAPTER 7

General discussion
Introduction

Degenerative cervical radiculopathy is a common neurological disorder, with an incidence rate of 83.2 per 100,000, manifesting with pain, paraesthesias and less often weakness in one arm radiating from the neck. The symptoms and signs originate from nerve root compression caused by degenerative disease of the cervical spine. In the general population degeneration can be seen as a sign of normal aging; only in a minority it causes radicular symptoms.

In our study we found that herniated disc was more often the cause of single root compression, whereas spondylarthrosis more often caused multiple root compression which could be (partly) asymptomatic. This is in contrast to a large study on root compression by Radhakriskan et al, who retrospectively investigated 561 patients with cervical radiculopathy. In this study, disc protrusion was the cause of root compression in only 21.9 percent of cases, whereas 68.4% had radiculopathy of uncertain pathogenesis associated with degenerative disease, which could be 'spondylosis, disc or both'. The remainder had other causes including spinal fractures. This article has often been cited and spondylosis has been considered as the most common cause of degenerative cervical radiculopathy. It is sometimes difficult to distinguish spondylosis from herniated disc on MRI, as was also seen in our study.

In the classic clinical picture patients have radicular pain and sensory disturbances in the corresponding dermatome, weakness of the muscles of the involved myotome (for instance m. biceps brachii for C6, m. triceps brachii for C7), and reduction or absence of corresponding reflexes (biceps in C5 root lesions, brachioradialis in C6 lesions or triceps reflex in C7 lesions). However patients rarely present with all symptoms and signs corresponding to the afflicted root. Unusual symptoms like radiation of pain to chest or scapula, have been reported as signs of cervical root compression. In this thesis only patients with typical clinical symptoms were included.

In most clinical cases, cervical radiculopathy can be easily differentiated from other causes of arm pain, like entrapment syndromes and neuralgic amyotrophy by a careful history and neurological examination. Clinicians should be alert for signs and symptoms indicative for myelopathy, like gait disability and bladder dysfunction, as spinal cord compression may occur together with degenerative radiculopathy. Different diagnostic tools, such as imaging modalities and needle electromyography (EMG), are
additionally utilized for confirmation of radiculopathy or excluding other diagnoses. However, there is not much evidence to appreciate its added value to the clinical observations.

Comparison of MRI with nerve conduction studies and needle electromyography yielded that sensitivity of MRI is higher (93 vs. 42%) than electrophysiology in the preoperative evaluation of patients with cervical radiculopathy. 24

This thesis comprises a three-armed randomised clinical trial of non-surgical treatments (collar, physiotherapy or wait and see) in patients who were referred by their general practitioner to the neurologist, with signs and symptoms consistent with recent onset cervical radiculopathy. Furthermore, in this thesis, the added value of additional diagnostic methods (MRI and EMG) to the clinical diagnosis was assessed. In this final chapter the results obtained in the studies described in the previous chapters will be discussed, with emphasis on their clinical implications, the applied methodology, and implications for further research.

Diagnosis

Clinical diagnosis
For our studies on recent onset cervical radiculopathy, we first established a clinical definition based on existing literature 6 13-18 in combination with our clinical experience. Our criteria for the clinical diagnosis of cervical radiculopathy were: radiation of arm pain distal to the elbow, plus 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, and/or (4) muscle weakness in one or more adjacent myotomes, in the absence of clinical signs of spinal cord lesions.

We performed several provocation tests in our standardised neurological examination; retroflexion, anteflexion, lateroflexion of the neck, Spurling’s foraminal compression test, and Lasegue’s arm sign (which can be seen as a variant of the shoulder abduction sign). Of these, only Spurling’s foraminal compression test and the shoulder abduction sign have been validated. The foraminal compression has been demonstrated to have low sensitivity and high specificity. The shoulder abduction test demonstrated low to moderate sensitivity and moderate to high specificity. 19-21 In every patient we performed
all of the above mentioned tests. The tests were considered positive when arm pain worsened. The definition for the entry criterion was at least one positive provocation test. Most patients had more than one positive test with retroflexion of the neck showing the highest percentage of positive results, followed by Spurling’s foraminal compression test.

In a guideline which was published in 2010 by the North American Spine Society (NASS) a working definition for cervical radiculopathy was established (working group consensus statement), showing great similarity with our criteria. The definition of the working group was as follows: ‘pain in a radicular pattern in one or both upper extremities related to compression and/or irritation of one or more cervical nerve roots. Frequent signs and symptoms include varying degrees of sensory, motor and reflex changes as well as dysesthesias and paresthesias related to nerve root(s) without evidence of spinal cord dysfunction (myelopathy).’ This definition implies that the diagnosis of degenerative cervical radiculopathy can be made on clinical grounds. The guideline considered provocative tests useful in clinical evaluation of cervical radiculopathy, but did not include them in their clinical definition.

Our criteria appeared to be accurate in practice, since none of the 205 patients diagnosed by our clinical criteria for cervical radiculopathy had other causes than herniated discs or spondylotic changes, nor did other conditions emerge during the follow-up period of 6 months. However, we gathered no data on interobserver variability and accuracy. For further research our criteria should be validated for accuracy and interobserver variability.

Ancillary investigations

Magnetic Resonance Imaging
Since its introduction, MRI is often used in patients with a clinical diagnosis of cervical radiculopathy to demonstrate the presence and cause of root compression, i.e. disc herniation or spondylotic foraminal stenosis, and the level of compression. The previously mentioned NASS guideline recommends MRI as the method of choice for the confirmation of disc herniation and spondylosis in cervical spine patients who have failed conservative therapy, and who may be candidates for interventional or surgical treatment.

When MRI is contra-indicated, computed tomography (CT) can be performed, and with equivocal MRI results CT myelography can provide more information. Several studies
have been conducted to compare MRI with other investigations, i.e., CT, CT myelography and electromyography (EMG). MRI images were found to have an accuracy of 87% for the diagnosis of foraminal encroachment, for CT myelography there was an accuracy of 90%, and gadolinium-enhanced MRI had no additional benefit. A study comparing MRI to surgical findings in 13 patients with known or suspected cervical radiculopathy showed that MRI identified 3 out of 3 herniations and 26 out of 27 other 'degenerative abnormalities', not otherwise specified. Based on these results, the authors concluded that diagnostic accuracy of MRI is sufficient for the evaluation of cervical radiculopathy. Comparison of MRI with nerve conduction studies and needle electromyography yielded that sensitivity of MRI is higher (93 vs. 42%) than electrophysiology in the preoperative evaluation of patients with cervical radiculopathy.

However none of these studies took observer variability into account, and in addition well-designed studies relating MRI abnormalities to clinical findings were not available. To assess the value of MRI we first studied interobserver variability of MRI in a large sample of patients with cervical radiculopathy. We found substantial interobserver agreement (kappa 0.67) of MRI diagnosis of root compression between two experienced neuroradiologists. Agreement on the cause of root compression, disc herniation (kappa 0.59) or spondylotic foraminal stenosis (kappa 0.63) was less robust.

In addition, we investigated the relation between the clinical and MRI level of root compression. Using the clinically affected root as gold standard we found corresponding root compression on MRI in 73 percent of patients. This percentage is similar to that found in a study of Henderson et al. In a retrospective series of 736 patients with cervical radiculopathy they compared the clinically suspected level with the compressed level found during surgery and it was shown that in 71.5% of patients the site of root compression could already be accurately predicted by clinical signs alone. It would be worthwhile to compare the predictive value of clinical data with that of MRI in a large surgically treated population. Such a study has not yet been performed as far as we know.

In 15% of our symptomatic patients MRI showed no root compression at all. One possibility is that negative MRIs in patients with a clear clinical diagnosis have to be considered as a technical failure of the MRI. Another explanation of false-negative MRIs is that in these patients the symptoms are caused by inflammation rather than compression by herniated discs or spondylotic foraminal stenosis. In earlier reports, signs of inflammation were found histopathologically. Inflammation therefore may
be an alternative explanation for radiculopathies without confirmed root compression, even though no root thickening is being visualised on MRI. A third explanation for our normal MRIs is that we have misdiagnosed some patients. However, none of our patients revealed another cause for their arm pain during the period of follow-up (6 months) corroborating the previously established diagnosis. We consider the first explanation the most likely one. Nonetheless, it can not be ruled out that some patients did not have cervical radiculopathy. In our studies on MRI we could not use surgical data as the gold standard, as suggested in the above-mentioned NASS guideline; only 13 out of our 205 patients needed surgical decompression.

In a clinical setting, performing a MRI has no clinical consequences for the majority of patients with recent onset cervical radiculopathy since the usual course is spontaneous recovery. We advise to perform MRI in the case of persistent pain exceeding a period of 6 to 8 weeks. This corresponds with the recommendation of the NASS guidelines. Also, MRI should be performed in cases with ‘red flags’, for instance indicating malignancy, spondylodiscitis, or myelopathy. All MRI findings should be interpreted cautiously and always in the clinical context.

MRI negative cases are an important subject for further research. The place for additional CT techniques like contrast enhanced Multidetector Computed Tomography (MDCT) should be established. It is a promising technique for better visualisation of bony deformations. With MDCT, foraminal stenosis can be detected that is missed on MRI. It would also be worthwhile to study the usefulness of dynamic MRI in neutral, flexion and extension position, especially but not exclusively in patients with a clinical diagnosis of cervical radiculopathy and a negative MRI, and of dynamic upright MRI.

Needle electromyography

Although MRI is the additional investigation of choice for detecting root compression, EMG is still often used. The NASS guideline concluded that no recommendations could be made for the use of EMG, as there is insufficient evidence.

We also found only limited usefulness of EMG for the diagnosis. In our EMG study we examined 176 patients with a standardised needle electromyography protocol in which the electrodiagnostic consultant was blinded for clinical and MRI data. We detected denervation activity in only 16.5 % of patients; the total number of abnormal EMGs in our study population was 39.2 %.
The main drawback of our study was the standardisation and limitation of the EMG protocol to 5 muscles. A more extensive EMG protocol, including the examination of more arm and also paraspinal muscles might have increased the percentage of abnormal EMGs.

It can be concluded that there seems to be no place for routinely performed standardised 5- muscle needle electromyography in patients with recent onset cervical radiculopathy. Needle EMG combined with conduction studies is useful when the diagnosis of radiculopathy is not solid, since it can differentiate between radiculopathy and other causes of arm pain, like compression of peripheral nerves, mainly the median and ulnar nerve, and lesions of the brachial plexus. 4 9 33 34

Further studies are needed to learn more on the value of EMG in patients with multilevel root compression on MRI. Additionally, it is still unclear what EMG can contribute in patients with a negative MRI; we also advise further research on this topic.

### Treatment

#### Pharmacological

There are no studies addressing the role of pharmacological treatment in the management of recent onset cervical radiculopathy from degenerative disorders. 20 35 A Cochrane review has shown significant efficacy of opioids in reducing the intensity of neuropathic pain of any kind (median duration of opioid use 28 days, range 8-70 days). 36 37

There is no literature available on pain reducing effect of specific neuropathic medications like pregabalin, topiramate, tricyclic antidepressants and carbamazepin, in recent onset radiculopathy. In chronic radiculopathy, these medications have no proven effect, except for the combination tricyclic antidepressants /opioids, which was effective in one study. 38-40

In our study we did not investigate the effect of analgetics. All our patients were free to use over the counter painkillers like paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), and if necessary we prescribed opiates. Patients reported the use of painkillers in their diaries. We compared the use of NSAIDs and opiates in the three treatment groups and found that the prescription and the use were similar in all three arms.
Collar, physiotherapy versus wait and see policy

Both negative and positive trials were published on the usefulness of physiotherapy in lumbar and cervical radiculopathy. However, study populations were heterogeneous, a description of the physiotherapy protocol was lacking and in general study methodology was substandard. We investigated the efficacy of a standardised physiotherapy program, with an emphasis on exercises. Our protocol was based on expert opinion of experienced physiotherapists. The complete exercise protocol has been added to this thesis (appendix 2).

We also included collar therapy as a treatment arm in our study. Studies convincingly showing a positive effect of the collar in cervical radiculopathy were notably absent. However, for many physicians prescription of a collar in cervical radiculopathy was still common practice as individual patients reported short term pain relief. The collar has been a common treatment modality for patients with all kinds of neck pain and particularly whiplash associated injuries. Several trials were conducted on the efficacy of the collar for patients with whiplash associated injuries. None of these studies showed positive effects of wearing a collar in these patients. Guidelines, based on these negative results, discouraged the use of collars. It was assumed that wearing the collar led to a delayed recovery and wearing a collar for longer periods might lead to atrophy-related secondary damage. Therefore, the collar has had a negative image for decades.

Our RCT showed that treatment with a semi-hard cervical collar in combination with taking as much rest as possible for three weeks, with a maximum of six weeks, or standardised physiotherapy and doing home exercises for six weeks resulted in a significant reduction in neck and arm pain as compared with a wait and see policy. We also found a small effect of the cervical collar and rest on functionality measured with the neck disability index (NDI), in contrast to physiotherapy and home exercises.

We have chosen to use the visual analogue scale (VAS), and the neck disability index (NDI) as outcome scales. Both scales have often been used and tested in trials on surgery in patients with cervical radiculopathy, and both the NDI and the VAS were found to be reliable and valid outcome measures to assess the outcome in trials on degenerative cervical radiculopathy. We used the Dutch version of the Neck Disability Scale (NDI-DV), which has been validated in the Netherlands for patients with neck pain. We considered non-disease specific quality of life scales like the SF-12
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57, the Patient Specific Functional Scale (PSFS) 64 and the SF-36 65 less appropriate for our population with mainly arm and neck pain, limited neurological deficit and marked recovery within 6 weeks.

Based on the results of our trial we advise a collar for 3-6 weeks combined with rest, in patients with recent onset cervical radiculopathy. We recommend a semi-hard collar, as hard collars are uncomfortable, whereas soft collars give insufficient support. Alternatively physiotherapy can be prescribed in combination with home exercises for six weeks.

Further randomised trials are needed to confirm our results. Also more research is needed to understand the mode of action of physiotherapy and collar therapy. Timing of the prescription of the collar, the period the collar should be worn and the effectiveness of different types of collar, also need more scientific evaluation. Wearing a collar in the acute phase followed by physiotherapy may very well yield better results than each of the treatment modalities alone.

In conclusion, this thesis reveals strengths as well as weaknesses of additional diagnostic examinations like MRI and EMG, in recent onset degenerative cervical radiculopathy. The main diagnostic tool remains a thorough history and neurological examination. Initial treatment of cervical radiculopathy may consist of wearing a semi-hard collar or physiotherapy.
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