Cervical radiculopathy: diagnostic aspects and non-surgical treatment
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CHAPTER 1

General introduction
Cervical radiculopathy

Degenerative cervical radiculopathy is a common cause of pain in the arm radiating from the neck with an annual incidence rate of 83.2 per 100,000. Symptoms and signs include sensory disturbances in arm and hand with dermatomal and motor weakness with myotomal distribution. Neck pain itself is usually present but is often minor compared to arm pain. The pain in the arm is caused by cervical root compression due to spondylosis or herniated discs, and is often severe, leading to function loss in the first weeks to months and causing a considerable impact on overall health status. The prognosis of degenerative cervical radiculopathy is often good with spontaneous relief of symptoms and signs over time in the majority of patients. Consequently surgical intervention is only needed in a minority of patients with ongoing pain. However, the severe pain in the first weeks requires pain relieving treatment modalities. In this thesis the results of our studies on diagnostic value of neurological examination, magnetic resonance imaging (MRI) and needle electromyography (EMG) as well as that of the effect of non-surgical pain relieving treatment in recent onset cervical radiculopathy are described.

Pathogenetic aspects

The complex of symptoms that we now associate with cervical radiculopathy was first described in the thirties of the previous century. In the earliest reports the cause of root compression was thought to be neoplasm, called enchondromas. Histopathological examination of resected enchondromas showed fibrous connective tissue characteristic of annulus fibrosus, which was thought to be neoplasm of the disc. Mixter and Barr’s landmark report, written in 1934, changed the view on root compression and disc disease. They reported a series of 19 surgically treated patients with root compression, four of which at the cervical level. They described histopathological findings and concluded that ruptured discs were a more common cause than cartilaginous neoplasm.

A case of cervical radiculopathy was also described by Nachlas in 1934; pseudoangina pectoris caused by hypertrophic changes in the cervical spine, later called hypertrophic arthritis as a cause of root compression. In 1936, Turner and Oppenheimer reported 50 cases, with what they called ‘discogenetic disease’, which was the cause of thinning of the intervertebral disc and narrowing of the intervertebral foramina. A detailed report by
Spurling and Segerberg on cervical disc disease in 1953 mentioned two distinct causes: osteophytic spur formation and rupture of the disc. This still represents the current opinion on causes of cervical root compression; herniated discs, foraminal stenosis or a combination of both.

In lumbar radiculopathy herniated discs have been shown to be the most common cause of root compression, in cervical radiculopathy this information is not available. It is assumed that foraminal root compression by spondylosis plays a more important role in the cervical spine than in the lumbar region.

**Diagnostic aspects**

In the early reports dating from the thirties and forties of the previous century the diagnosis of cervical root compression was based on clinical signs and symptoms. Additional diagnostic methods such as electromyography, X-rays of the cervical spine and protein concentration in the cerebrospinal fluid were available but their usefulness was limited. Electromyography has been used in cervical radiculopathy since the forties of the previous century; the earliest report as far as we know is from Brazier in 1946. In her report she describes the technique of electromyography as a delicate tool capable of showing abnormal spontaneous muscle activity in patients with root compression. EMG is still used as a diagnostic tool in this condition but well designed studies assessing its diagnostic value are lacking. X-rays may show narrowing of the foraminal space, but this is often an asymptomatic feature. An elevated protein level in the cerebrospinal fluid has been reported to support the diagnosis; however this finding is neither specific nor sensitive. Intrathecal injection with radio opaque contrast agents such as poppy seed oil, lipiodol, opamidol or iohexol were used to verify root compression on X-rays. Although potentially helpful this invasive technique was unreliable with low sensitivity while associated with complications.

The development of Computed Tomography (CT) allowed for showing the herniated disc, spondylotic changes and root compression. CT myelography became the gold standard for the demonstration of root compression in the eighties of the previous century. Currently MRI has replaced CT-scan as the primary diagnostic tool due to its superior imaging quality and better patient safety. MRI allows better detection of the presence
and cause of root compression but its true diagnostic accuracy for cervical radiculopathy has yet to be determined.

MRI gives us detailed information on anatomy, for instance it shows us the root itself and degenerative changes compressing the root. However, from studies in lumbar radiculopathy we learned that asymptomatic abnormalities also occurred (false positive), and vice versa, patients with a clinical diagnosis of lumbar radiculopathy without root compression on the MRI were also found (false negative).\textsuperscript{20-22} Despite the frequent use of MRI, this crucial information, necessary for good interpretation of MRI results, is not available for the cervical spine.

**Therapeutic aspects**

Several early reports describe surgical techniques performed in those days. The article by Semmes and Murphy from 1943 provides interesting details of 3 operated cases: under local anaesthesia the cervical laminas were exposed and the involved nerve root was identified by the patient by gentle pressure applied on the ligamentum flavum reproducing the exact pain. This test was done before any bone was removed. Then a subtotal hemilaminectomy was performed and the loose fragments and the bulging parts of the disc were removed.\textsuperscript{15} Also conservative, non-surgical therapies were addressed. For instance, Spurling stated in 1953 that the only indication for surgery is severe neurological deficit. Nonetheless in his series of 110 patients with cervical radiculopathy 30% was treated surgically.\textsuperscript{10} The conservative therapies in the forties and fifties of the previous century were traction of the cervical spine, bed rest or massage.\textsuperscript{10, 14, 15} In 1966, a large trial was performed on non-surgical therapy of cervical radiculopathy. In this trial different therapies were compared; cervical collar, physiotherapy with traction, physiotherapy with exercises and placebo therapy. The study was not conclusive.\textsuperscript{23} Later trials using cervical collar or physiotherapy also did not sufficiently clarify the issue of pain relieving modalities in recent onset cervical radiculopathy, as only patients with long lasting pain were included.\textsuperscript{24, 25}
Chapter 1

Aims and outline of this thesis

Despite its frequent occurrence, little is known on diagnosis and nonsurgical treatment of cervical radiculopathy. Contemporary literature often focuses on surgery, although this is only performed in a minority of patients. Diagnosis and treatment of cervical radiculopathy is done by general practitioners, neurologists, neurosurgeons and physiotherapists. Clinical trials evaluating the use of diagnostic tools, long term outcomes, as well as efficacy of conservative treatments, are scarce. Consequently there is no consensus on diagnostic criteria or treatment. We have designed a multicenter randomised controlled trial evaluating the two most commonly used non-surgical treatments; physiotherapy and cervical collar. Within the framework of this trial we explored the major diagnostic challenges of cervical radiculopathy.

To learn more on the existing knowledge of degenerative cervical radiculopathy we first performed a review of the literature, the results of which are presented in chapter 2. We have reviewed studies on epidemiology, pathophysiology, clinical diagnosis, electrophysiological examinations, imaging studies and the various types of non-surgical treatment of cervical radiculopathy. After reviewing the existing literature we established criteria for the clinical diagnosis of cervical radiculopathy to be used in our studies on MRI, EMG and non-surgical treatment.

Chapters 3 and 4 deal with magnetic resonance imaging (MRI), currently the most often used imaging technique in patients with symptoms of cervical radiculopathy. MRI is used to demonstrate the presence and cause of root compression in patients with a clinical diagnosis of cervical radiculopathy. Although MRI provides many details, it is questionable if these correlate well with the clinical symptoms and signs. In our MRI study we first determined the interobserver variability of MRI evaluation of herniated discs, spondylotic neuroforaminal stenosis and root compression in patients with cervical radiculopathy. Also the effect of disclosure of clinical information on interobserver variability was examined (chapter 3). After that we studied the correlation between clinical symptoms and signs and the abnormalities as reported by the blinded neuroradiologists (chapter 4), data that are important for a correct interpretation of MRI results.

Chapter 5 describes the results of our needle electromyography (EMG) study. Although many studies were performed on EMG in cervical radiculopathy since the forties, there is still no consensus on its usefulness in daily practice. Highly varying sensitivities were
reported, but blinded studies in a large study population are not available. \cite{31,32} Therefore our electrodiagnostic consultants, who were blinded for clinical and MRI data, examined all patients using a limited standardized electromyography protocol.

As shown in chapter 2, evidence for the effectiveness of any non-surgical therapy, including cervical collar or physiotherapy, is lacking. Treatment in acute or subacute cervical radiculopathy has not been studied at all. In the past non-surgical treatment of the even more frequently occurring lumbosacral radiculopathy has been studied, showing that standardised physiotherapy or bed rest did not produce better results than watchful waiting and continuing daily activities as much as possible. \cite{33,34} With the results of the trials on lumbosacral radiculopathy in mind it seemed useful to investigate whether there is evidence for efficacy of conservative treatment of early onset degenerative cervical radiculopathy. We conducted a randomised trial to compare the effect of cervical collar and physiotherapy with a wait and see policy. The results of this trial are shown in chapter 6. Appendix 1 of this thesis contains a Dutch version of the trial, published in the Nederlands Tijdschrift voor Geneeskunde. Appendix 2 contains our physiotherapy protocol.

The overall results of this thesis are discussed in chapter 7; which includes a general discussion and a summary of the results.


