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Prognostic value of MRI findings in sciatica

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Abstract The natural course of sciatica due to disc herniation is generally favourable but individually unpredictable. Some patients recover only after prolonged conservative therapy or surgery. This study aims to ascertain whether magnetic resonance (MR) imaging features can be used to predict outcome of sciatica and help to identify patients unlikely to respond to conservative management. For a transversal diagnostic study 274 primary care patients underwent early MR imaging for leg pain. One hundred and thirty-three patients with sciati-

ca were followed for 3 months, both patients and physicians being unaware of MR imaging findings. At 12 weeks a favourable prognosis was indicated by the following features: annular rupture ($P=0.02$) and nerve root compression on MR imaging ($P=0.03$). Poor prognosis was indicated by disc herniation in the foramen ($P=0.004$). Our findings show that early MR imaging features are related to prognosis. However, the associations are not strong enough to justify routine use of early MR imaging to predict the prognosis of sciatica.

Introduction

The natural course of sciatica due to disc herniation is favourable [1, 2] and the major management challenge at first is adequate pain reduction [3]. Magnetic resonance (MR) imaging is the standard ancillary investigation. In the Netherlands a consensus is reached that MR imaging is only indicated in later stages of disease when surgical treatment arises as a therapeutic option [4]. Of course, an additional indication is when another pathological condition besides disc herniation, such as vertebral metastasis, is suspected. The present study investigated whether there may be an indication for early MR imaging to predict the further course of disease. Ordering of MR scans in an early stage of disease, possibly by general practitioners, might allow the recognition of patients likely to have unfavourable courses and might improve patient selection for additional procedures.

An investigation of the prognostic value of MR imaging in primary care patients has not been done. Carragee et al. [5] have retrospectively studied clinical

and MR findings that might predict unfavourable outcome. In this study, patients must have been selected on the basis of a sufficient duration and an unfavourable course of disease to have had an indication for MR imaging, as it is not standard practice to perform MR imaging at first presentation of sciatica.

As part of a diagnostic and patho-anatomical study, 274 patients were seen in the neurological outpatient clinic within 3 days of the first consultation with their general practitioner for an episode of pain radiating into the leg. All these primary care patients had a standardized history and physical examination and underwent MR imaging. Both patient and physicians were blind to the results of MR imaging. The results of this transversal study are reported elsewhere. In 183 of the 274 patients with leg pain, a clinical diagnosis of sciatica due to disc herniation was made, and a prospective evaluation of the outcome was undertaken. These patients were the subjects of a study to investigate whether the initial concealed MR findings could predict outcome.

Methods

Study population

Between February 1995 and December 1996, 50 general practitioners (GPs) in Maastricht and surrounding villages referred patients to the Department of Neurology at Maastricht University Hospital for a study on sciatica. Included were patients with pain radiating into the leg below the knee. Exclusion was based on previous spinal surgery, pregnancy, unavailability for follow-up visits and co-morbidity such that well-being was primarily determined by this co-morbidity. Patients were also excluded if there was an indication for immediate surgery (morphine-dependent, intractable pain, progressive or severe paresis of limited duration or cauda equina syndrome). All patients selected entered a transversal study of the value of history and physical examination in patients with pain in the leg, the results of which have been published elsewhere [6].

For the present study additional inclusion criteria were applied. Only included were patients with a new episode of pain radiating into the leg below the gluteal fold, of sufficient intensity to justify further treatment, and with at least two of the following signs or symptoms: typically radicular pain distribution, pain in the leg increasing with coughing/sneezing/straining, decreased muscle strength, sensory loss, reflex loss, positive straight leg raising test. In these patients the outcome was prospectively followed.

Baseline investigations

All patients selected were examined within 2 days of GP referral. This included a standardized history and physical examination, the technique and inter-observer variability of which are reported elsewhere [6], and MR imaging.

MR imaging assessment

The MR imaging assessment is shown in Fig. 1

The gold standard in all patients was MR imaging of the lumbar spine (for study purposes, within 12 h of the clinical examination). This was performed with a 0.5-T system according to the following scanning protocol: (1) sagittal and transverse T1-weighted spin-echo sequences (TR/TE 400–600/20 ms) with 4- and 5-mm slice thickness, respectively, and (2) a sagittal proton density-T2-weighted fast spin-echo sequence (TR/TE) with 5-mm slice thickness. Additionally, MR radiculography was performed consisting of two heavily T2-weighted fast spin-echo sequences (TR 6,000, TE 450 ms), orientated about 20° left- and right-oblique to the coronal plane, reformatted by maximum intensity projection [7]. One neuroradiologist assessed all MR scans. Nerve root compression was graded as absent, uninterpretable or present on the standard MR images and MR radiculography, separately. Nerve root compression on the standard axial and sagittal MR images was estimated on the basis of deformation of the dural sac, root sleeve and/or extradural root segment, by displaced disc material and/or narrowing of the central spinal canal, lateral recess or intervertebral foramen. Obliteration of epidural fat around the root sleeve or epidural root segment was also looked for.

On MR radiculography images, compression of the border of the dural sac and root sleeve was looked for, as well as kinking and/or swelling of the intradural root segment. A more detailed and illustrated description of the assessment of nerve root compression on sectional and radiculographic images is given in the references [7, 8]. The site of nerve root compression was registered as follows: none/dural sac/shoulder of nerve root sleeve/axilla of nerve root sleeve/dorsal root ganglion. There were additional assessments with regard to annular rupture (absent/ uninterpretable/ present), degeneration of nucleus pulposus (one level/none/all levels), and

disc herniation (type: none/bulge/protrusion/extrusion/migration and site: none/median/paramedian/mediolateral/intraforaminal/extraforaminal). The clinical investigator and the neuroradiologist were unaware of MR and clinical findings, respectively. Intra-observer variability was established by re-grading 80 MR scans.

Outcome parameters

Outcome was assessed at 2 and 12 weeks for patients treated conservatively up until the second follow-up at 12 weeks as follows:

1. Patients were asked to register the global perceived effect after 2 weeks on a 5-point scale (strong worsening/worsening/no change/improvement/strong improvement). In the statistical analysis, variables that might predict the category "strong improvement" were investigated. None of the patients underwent surgery in this 2-week period.
2. Patients were asked to register the global perceived effect again after 12 weeks (in comparison with their condition at 2 weeks).

In order to define the outcome as favourable or unfavourable the global perceived effect was dichotomized. The categories improvement and strong improvement after 12 weeks were termed "favourable". Also, if there had been "no change" but the complaints had already improved greatly at the 2-week assessment, the outcome was termed "favourable".

Treatment during the evaluation period

Additional therapies were carried out during the follow-up period. Only if surgery seemed indicated on the basis of the clinical picture, were the MR findings revealed to the treating physician. Because surgery is known to alter outcome and because the final indication for surgery is also based on MR findings, patients treated surgically were not investigated in the final analysis. The relationships between MR findings, surgery and outcome were investigated, however.

Statistical analysis

The percentage of patients with a favourable outcome was calculated for patients with and without the MR finding. None of these patients were operated on. For the bivariate analysis of MR findings versus outcome, chi-square analysis was used. The effect of excluding patients treated surgically from the analysis was investigated (because of the bias that might result from this exclusion). Also, the percentage of patients with a favourable outcome of surgical treatment was determined to see whether surgery might be a confounding variable in the prediction of outcome. For those MR findings with a higher percentage of patients treated surgically, a logistic regression model was constructed with the particular MR finding, the occurrence of surgery and a product term of surgery and the MR finding.

Results

Two hundred and seventy-four patients with pain radiating into the leg had been included in a transversal diagnostic study. Of these, 183 patients had had a clinical diagnosis of nerve root involvement. Twenty-two patients could not undergo MR scanning due to MR contra-indications (e.g. metal-containing foreign body, pacemaker, claustrophobia). The baseline characteristics for these patients were not significantly different from

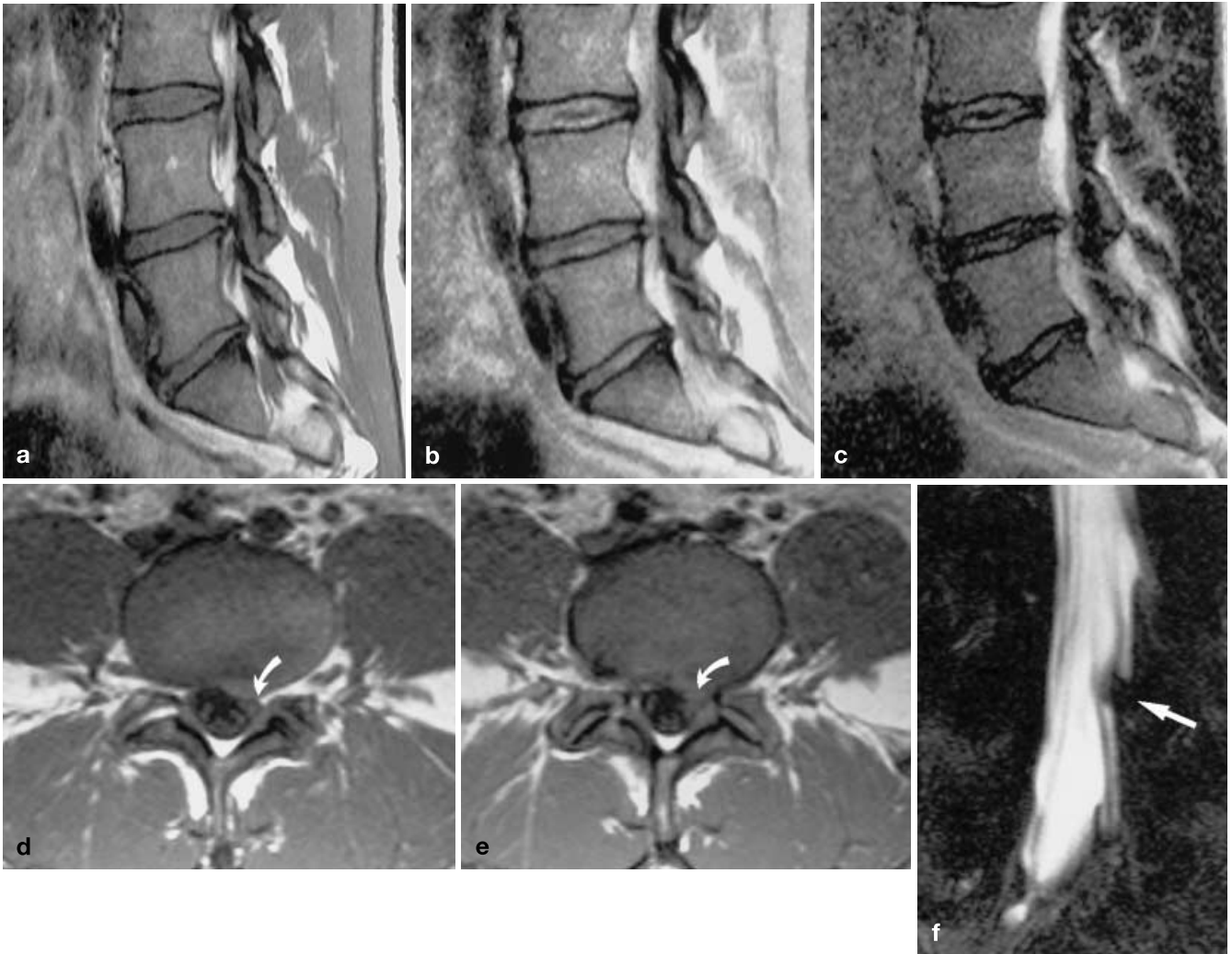


Fig. 1. MR imaging assessment

those who did undergo MR scanning. For the evaluation of the predictive value for the outcome at 2 weeks, 161 patients were available. Twenty-four patients had undergone surgery and were therefore excluded from our analysis of the prognostic value at 12 weeks' follow-up. Four other patients were lost to follow-up at 12 weeks. Clinical and MR imaging findings and outcome at 2 and 12 weeks could thus be determined for 133 patients. Forty-one patients were 16–40-years old, 53 were 41–50-years old and 39 were 51–81-years old. Seventy-three were male and 60 female. Sixty-seven patients had a disease duration of less than 14 days, 31 of 15–30 days and 35 of more than 30 days. Eighty-eight patients had a positive straight leg raising test and 25 had paresis. There was a favourable outcome at 2 weeks for 58 of 161 patients and at 12 weeks for 115 of 133 patients.

Intra-observer variability for the MR imaging findings under investigation are mentioned in Table 1.

Rupture of annulus fibrosus was the only MR imaging finding significantly associated with strong improvement after 2 weeks. Patients with annular rupture had a 43% chance of strong improvement after 2 weeks compared with a chance of 27% for patients without annular rupture ($P=0.03$).

Table 2 shows the associations between MR findings and the percentage of patients who reported reasonable improvement after 3 months. Reasonable improvement was indicated by nerve root compression on MR imaging, and annular rupture, while a poor prognosis was indicated by foraminal disc herniations. There were trends for compression of the nerve root in the axilla ($P=0.08$) and mediolateral disc herniations ($P=0.06$) to be related to a better outcome.

The patients in the group treated surgically had a slightly better outcome. The exclusion of these patients from our prognostic study might introduce a bias if

patients with particular MR findings are more or less likely to undergo surgery. This was the case for three findings: nerve root compression on MR imaging, disc herniation and annular rupture were related to eventual surgery. Notably, there was a greater number of patients with a favourable outcome in those with disc herniation and annular rupture in the surgical group as well. Also, the logistic regression analysis, in which surgery was treated as a confounding and effect-modifying variable, provided identical estimates of predictive value and statistical significance to the results of the univariate analysis depicted in Table 2.

Discussion

Our study shows that several MR findings were related to the prognosis of the patient with sciatica due to disc

herniation. This is not in agreement with Carragee and co-authors who found that none of the MR findings in the population treated conservatively predicted outcome, while relatively small disc herniations (less than 6 mm) predicted a poor prognosis in the population treated surgically [5]. Reasons for the differences found are that the populations studied by Carragee et al. were probably more severely affected, and the MR findings in their study were not established at an early stage of disease. Moreover, in our study the size of the disc herniation was not investigated. The size of the disc herniation is only relevant in relation to the dimensions of the canal. A roomy canal can accommodate larger herniations than a narrow canal before root compression occurs.

Table 2 shows the associations between MR findings and outcome. For instance, patients with foraminal disc herniations have a 67% chance of reasonable improvement over the next 3 months while patients without foraminal disc herniations have a 90% chance of reasonable improvement. The unfavourable prognosis of foraminal herniations is not explained by a higher rate of surgery in this group.

It is in keeping with the literature that an MR diagnosis of nerve root compression does not predict unfavourable outcome [9]. Several papers have underlined the favourable natural course of sciatica due to disc herniation [2, 10, 11]. One paper has shown that sciatica does not respond any better to bed rest whether there is MR evidence of nerve root compression or not [12].

Table 1. Intra-observer variability for MR imaging

MR imaging findings	Kappa
Nerve root compression	1.0
Nerve root compression on MR radiculography	0.83
Annular rupture	0.92
Disc herniation	0.83
Site of root compression (none/dural sac/shoulder/axilla/dorsal root ganglion)	0.60
Site of disc herniation (none/medial/paramedial/mediolateral/foraminal)	0.52
Nerve root level (none/L3/L4/L5/S1)	0.81

Table 2. MR imaging findings related to favourable outcome after 12 weeks

MR imaging finding		Patients improved (%) ^a	<i>P</i> ^b	Patients operated on (%)
Compression	Present (69)	93	0.03	18 (21)
	Absent (64)	80		6 (9)
Disc herniation	Present (87)	89	0.34	23 (21)
	Absent (46)	83		1 (2)
Annular rupture	Present (71)	93	0.02	19 (21)
	Absent (62)	79		5 (8)
Root ganglion compression	Present (37)	84	0.58	10 (21)
	Absent (96)	88		14 (13)
Compression of root in axilla	Present (38)	95	0.08	8 (17)
	Absent (95)	83		16 (14)
Compression of root in shoulder	Present (37)	87	1.0	13 (26)
	Absent (96)	87		11 (10)
Compression of root in dural sac	Present (23)	78	0.20	2 (8)
	Absent (110)	88		22 (17)
Medial disc herniation	Present (40)	83	0.38	6 (13)
	Absent (93)	88		18 (16)
Mediolateral disc herniation	Present (40)	95	0.06	9 (18)
	Absent (93)	83		15 (14)
Foraminal disc herniation	Present (21)	67	0.004	3 (13)
	Absent (112)	90		21 (16)

^aThe percentages of patients with the MR findings mentioned that had improved after 3 months, irrespective of eventual surgery

^bBased on chi-square analysis

In our study annular rupture is related to outcome. It may be hypothesized that the rupture of annulus fibrosus facilitates regression of disc herniation in comparison with non-ruptured annuli. We have previously shown that in comparison with other sites of root compression, compression in the axilla of the nerve root is related to the typical clinical picture of nerve root compression: typically dermatomal pain distribution, pain increase on coughing, sneezing or straining, positive SLR and Kemp test [13]. It seems that this typical clinical picture and the underlying axillary root compression are more likely to resolve irrespective of conservative or surgical therapy. On the contrary, compression of the root in the dural sac or foraminal disc herniation have less favourable courses. Generally, cases of dural sac compression are less typical in their clinical presentation and may show considerable overlap with pseudo-radicular pathology. Selecting the appro-

priate treatment is more difficult then. Foraminal disc herniations may be complicated by bony encroachment of the intervertebral foramen. The latter will not spontaneously regress, and surgical treatment of foraminal disc herniation is less straightforward.

We have shown how some MR findings are related to the outcome of the natural course. These relationships are not, however, strong enough to allow an accurate detection of patients likely to have an unfavourable natural course. The ordering of early MR imaging by primary care physicians to predict the natural course of patients with sciatica due to disc herniation is therefore not supported by these findings. It should be noted that this does not preclude the use of MR findings to define subpopulations of patients who might benefit from particular types of therapy. The latter use of MR imaging was not the topic of this study.

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