Comparison of Prevalence of Degenerative Findings on Lumbar MRI among Sciatica Patients classified using the McKenzie Method.

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Abstract

Purpose To determine if the prevalence of degenerative findings on MRI differ between sciatica patients with radiating pain below the knee assigned into two groups by using the McKenzie method.

Methods A comparative study of one hundred sciatica patients referred to the spine clinic at the hospital for specialist consultation to explore the need for surgery. Patients were classified into centralizers (CEN-group), in which leg pain is relieved in response to repeated specific exercises, and non-centralizers (Non-CEN-group), who have not responded. The latter have been shown to have surgery more often than patients in the CEN-group, hypothesized to have more progressed degenerative findings on MRI. Multiple lumbar MRI characteristics were scored and compared between the groups.

Results There was a statistically significant difference in the degenerative findings between centralizers and non-centralizers, respectively: vertebral end-plate changes were 63% and 43%; mean (SD) Pfirrmann's disc degeneration score was 12.8 (±3.5) and 10.6 (±3.8); and severity score of total damage was 12.0 (±3.5) and 10.1 (±3.8). The prevalence of disc prolapses were 76% in the CEN-group and 59% in the Non-CEN-group. Further, 75% in the CEN-group and 74% in the Non-CEN group had nerve root compression due to disc herniation with no statistically discernible difference between the groups.

Conclusion Disc contour changes on MRI were similar between both groups as well as prevalence of nerve root compressions, but more progressed disc changes on MRI were found in centralizers than in non-centralizers. Thus, neither disc nor overall degenerative findings in sciatica patients can be used to determine types of radicular pain.

Introduction

Magnetic resonance imaging (MRI) is considered the mainstay investigation among patients who are candidates for disc surgery suspected of lumbar disc herniation (LDH), and the symptoms have not resolved within 6 weeks as expected with conservative treatment [1,2]. Both imaging and clinical signs and symptoms determine the final decision for surgery in sciatica patients with radiculopathy.

LDH accounts for less than three percent of all low-back problems but is the most frequent cause of sciatic or radicular pain [3]. LDH may take the form of bulged, protruded, prolapsed, or extruded disc material [4]. Low back and radicular pain may also be produced by structural bony changes such as stenosis, degenerative disc- [5] and Modic-changes [6,7], however these changes can also be found in the asymptomatic population [8].

Radicular pain is sharp pain that travels along a narrow band and arises as a result of irritation of a spinal nerve or its roots and can be associated with other signs of radiculopathy [9]. In radiculopathy, conduction is blocked in the axons of a spinal nerve or its roots by compression or inflammation [9]; in sensory axons this results in numbness, and in motor axons in weakness [9].

The McKenzie method of mechanical diagnosis and therapy (MDT) has been shown to be a reliable, and validated assessment, classification, and therapy method [10,11]. The method has been scored highest of any musculoskeletal therapy classification system for low-back related leg pain [12].
The MDT method classifies patients with radicular symptoms with repeated movements and sustained postures into subgroups to determine appropriate management strategies and prognosis into centralizers (CEN-group), and non-centralizers (Non-CEN-group) [10]. In the CEN-group, radiating pain is lastingly abolished with specific exercises, which has been shown to predict good non-surgical treatment outcomes [13]. Whereas, in the Non-CEN-group patients radiating pain remains unchanged or worsens when assessed with mechanical loading, and patients in this group have been shown to have significantly worse pain, disability and psychosocial outcomes compared to the CEN-group in the short and long-term [13,14]. Furthermore, patients in non-CEN-group are six times more likely to undergo disc surgery compared to patients in the CEN-group [13], and thus might be hypothesized to have more progressed degenerative findings and disc changes on MRI.

The purpose of this study was to determine in patients with sciatica if degenerative findings on MRI differ between non-CEN and CEN-groups according to the McKenzie method. We hypothesized that non-centralizers have significantly more progressed degenerative findings and disc contour changes compressing a nerve root on MRI than centralizers.

Methods

Trial procedure

Patients diagnosed with sciatica (N= 132) in primary or occupational health care were referred for further investigations to the spine clinic of a tertiary hospital. Inclusion criteria were age 18-to-65-years, and lumbar radicular pain that had lasted at least six weeks. Exclusion criteria were pregnancy, previous low back surgery, serious diseases or "red-flags" including cauda equina syndrome (CES) or lower limb palsy that hindered normal functioning, previous high or moderate energy trauma, or osteoporotic fractures for the elderly.

If the medical examination at the spine clinic suggested that the patient may have radiculopathy and need for surgery, they were referred for a lumbar MRI. While waiting for their MRI scan, patients underwent a clinical McKenzie-based assessment by one of two physiotherapists specially trained to perform the examination, and both with several years of clinical experience. Finally, one hundred patients (76%) met the criteria, and were classified into the two groups. After an oral and written explanation, patients signed informed consent for their participation in the study. All protocols adhered to relevant ethical guidelines and regulations. This study was performed at the Department of Physical and Rehabilitation Medicine, Central Finland Health Care District Hospital, Jyväskylä, Finland. The study was approved by the Ethics Committee of Pirkanmaa Hospital Districts, Tampere, Finland and registered (ETL-code R12198) and is conducted in accordance with ethical principals of the declaration of Helsinki. The data of this cross-sectional study is the baseline data of a randomized clinical trial registered on the Clinical Trial.gov site (ID: NCT03572452)

Can Sciatica Patients Avoid Surgery? https://clinicaltrials.gov/show/NCT03572452, 2018 | added to CENTRAL: 31 January 2019.

The McKenzie Classification

The clinical assessment used a formal McKenzie Institute’s Lumbar Assessment Chart with a thorough history taking and physical examination. These included a visual assessment of spinal ranges and quality of movements;
the anatomical location of dominant pain; and neural examination of nerve tensions, key muscle strengths and light touch sensitivity tests. This was followed by a standardized loading strategy testing with single and repeated end-range movements and / or sustained end-range positions in flexion, extension, lateral side-gliding /bending and rotation in loaded and in unloaded positions. The full clinical assessment lasted 90 minutes.

Before repeated end-range movement testing patients stood with their spine erect and recorded on a pain drawing the exact location of the present pain. After the repeated end-range movement testing, patients completed a second pain drawing blinded to the first drawing. The assessor compared drawings, and the exact site and any change in the location or intensity of low back and radicular pain was recorded.

The patients were assigned into the CEN-group (n=51), if pain was decreased or abolished distally, but remained more centrally, and remained so after getting up from the treatment couch while walking around for at least three minutes. The patients were assigned into the Non-CEN-group (n=49), if there was no change in location or intensity of the leg pain or symptoms only peripheralized more distally, or the most distal pain increased in intensity.

**MRI findings**

Images were first assessed by a resident orthopedic surgeon, who was specifically trained to classify degenerative changes on MRI and was familiar with reading MR images of the spine (JR). Multiple MRI characteristics of the degenerated findings were scored from spinal levels L1 to S1, using both increased signal on T2-weighted/fluid-sensitive sequences and decreased signal on T1-weighted images. Classification of lumbar disc was based on lumbar disc nomenclature: version 2.0 (4) with bulging, protrusion or prolapse of the lumbar disc. The location of nerve root compressions due to prolapsed discs was assessed by a physiatrist (JY) with extensive experience in clinical practice and reading MR images.

Disc degeneration was classified according to Pfirrmann's grading system [5]. Classification is scored from 1 point referring to no degenerative changes to 5 points referring to the disc as inhomogeneous with a hypointense black signal intensity, no differentiation between the nucleus and annulus, and the disc space is collapsed. Degenerative spondylosis was classified using the Kellgren classification [17]. The Kellgren classification is scored from 0 points referring to no degenerative changes to 4 points for severe narrowing of the disc with sclerosis and large osteophytes [17]. The presence of Modic changes [5,18] was assessed and classified in three subgroups: Modic type 1 changes, result from bone marrow edema and inflammation, Modic type 2 changes associated with fatty degeneration of the bone marrow and Modic type 3 changes with subchondral bone sclerosis, representing different stages of the same pathological process [19]. Furthermore, degeneration of end plate, a cartilaginous layer between the intervertebral disc and the vertebra, was assessed using the total end-plate score (TEPS) [7]. The TEPS was assigned to each disc separately using a 6-point-scale from 1 (no changes) to 6 (complete end plate damage, irregularity, and sclerosis of the end plate). In spinal stenosis, a portion of the spinal canal narrows to the point at which it exerts compression on the spinal nerves. Spinal stenosis was considered present when the thecal sac measured less than 100mm\(^2\) in surface area or in case of obliteration of perineural fat and compression of lateral recess or foramen. Nerve root canal stenosis was considered present if there was narrowing of the nerve root canal due to osteoarthritis. Spondylolysis was assessed from the MRIs and was considered as a break in the pars interarticularis. Spondylolisthesis was assessed by measuring the anterior and posterior walls of the vertebrae in relation of adjacent vertebrae.
Sociodemographic characteristics and clinical outcomes

Data were collected on sociodemographic characteristics: age, gender, body mass index and smoking. Duration of the spinal disorders were measured in years, and duration of the present symptoms in weeks. Low back and leg pain intensities during last week were assessed with a visual analogue scale (VAS) [15]. Disability was captured using the Finnish version of the Oswestry Disability Index (ODI) [16].

Data analysis

The descriptive statistics are presented as means with standard deviation (SD), as medians with interquartile range (IQR) or counts with percentages. Statistical comparisons between the groups were made using the t-test, Mann-Whitney U test or chi-square test. In the case of violation of the assumptions (e.g. non-normality) for continuous variables, a bootstrap-type method or Monte Carlo p-values (small number of observations) for categorical variables were used. The normality of variables was evaluated graphically and by using the Shapiro–Wilk W test. No adjustment was made for multiple testing, but this information can be obtained by multiplying the actual p-value by the number of comparisons made. The Stata 16.1, Stata Corp LP (College Station, TX, USA) statistical package was used for the analysis.

Results

Demographic

data In the present study the duration of radicular pain median was 16 weeks (IQR 12-24) in the CEN-group, and 20 weeks (IQR 12-28) in the Non-CEN-group. Current low back pain intensity was significantly stronger in patients in the Non-CEN-group and the patients were significantly more disabled than patients in the CEN-group, p=0.008, and p<0.001 respectively (Table 1).
Table 1

Comparison of sociodemographic and clinical outcomes of the sciatica patients classified by the McKenzie method into the CEN- and the Non-CEN-groups (N=100).

|                           | CEN (n=51) | Non-CEN (n=49) | P-value |
|---------------------------|------------|----------------|---------|
| Age, years mean, (SD)     | 45(10)     | 43(12)         | 0.36    |
| Gender, number of female n (%) | 28(55)     | 25(51)         | 0.70    |
| Body-mass index, mean (SD)| 28.0(5.1)  | 27.2(4.2)      | 0.37    |
| Height, cm, mean (SD)     | 172(10)    | 172(12)        | 0.89    |
| Weight, kg, mean (SD)     | 83(17)     | 81(18)         | 0.51    |
| Smoking, n (%)             | 18(35)     | 12 (25)        | 0.27    |
| Duration of spinal disorder, years, median (IQR) | 8 (2, 15)  | 7 (1, 17)      | 0.78    |
| Duration of present symptoms, weeks, median (IQR) | 16 (12, 24) | 20 (12, 28)   | 0.32    |
| Current leg pain intensity, (0-100) mean (SD) | 52(22)     | 62(27)         | 0.06    |
| Current low back pain intensity, (0-100) mean (SD) | 41(25)     | 56(30)         | 0.008   |
| Current Disability, (Oswestry-index) mean (SD) | 31(11)     | 44 (15)        | <0.001  |
| Present motor weakness, n (%) | 45(88)     | 43(88)         | 0.94    |
| Present sensory disturbance, n (%) | 28(55)     | 31 (63)        | 0.39    |
| Present asymmetric decrease in reflexes, n (%) | 18(35)     | 20(42)         | 0.51    |
| Positive SLR (5-45 deg), n (%) | 33(65)     | 36(73)         | 0.34    |
| Primary Directional Preference, n (%)                  | Extension in prone lying | 11(21) |
|                                                          | Lateral in standing     | 6 (12)  |
|                                                          | Rotation in supine      | 34(67)  |

CEN = centralizers, Non-CEN = non-centralizers

**MRI findings**

The prevalence of lumbar disc contour changes (bulging, protrusion, prolapse) were 96% in the CEN-group and 86% in the Non-CEN-group (p=0.09). The prevalence of disc prolapses were 76% and 59%, respectively (p=0.07).

Thirty-eight patients (75%) in the CEN-group and thirty-six (74%) in the Non-CEN-group had nerve root compression due to intervertebral disc herniation (p=0.44, Table 2). Among other degenerative findings, 63% in the CEN-group and 43% in the Non-CEN-group had Modic changes (p=0.05). Modic type 1 changes, resulting from bone marrow edema and inflammation was found among 10 patients in each of the two groups. Modic type 2 changes,
entailing fatty degeneration of the bone marrow, and Modic type 3 changes with subchondral bone sclerosis was found in 22 and 11 patients in the CEN- and the Non-CEN- groups, respectively. Mean Pfirrmann's score was 12.8 (SD ±3.5) in the CEN- group and 10.6 (±3.8) in the Non-CEN- group (p=0.003), and mean TEP score was 12.0 (±3.5) and 10.1 (±3.8), respectively (p=0.01), which were most significant at L4-L5 level. More detailed findings are in Table 3. Spondylosis was a more common finding in the CEN-group than in the Non-CEN-group (0.03). There were no other statistical differences between the groups with regard to spondylolysis, spondylolisthesis, and prevalence of central, foraminal, and lateral recess stenosis (Table 2).
Table 2
Comparison of lumbar disc contour changes and bony structural findings on MRI between sciatica patients classified by the McKenzie method in the CEN- and the Non-CEN-groups (N=100).

|                               | CEN (n=51) | Non-CEN (n=49) | p-value |
|-------------------------------|------------|----------------|---------|
| Bulging discs, n (%)          | 4(8)       | 2(4)           | 0.68    |
| Protrusions, n (%)            | 22(43)     | 28(57)         | 0.16    |
| L1-L2                         | 0(0)       | 1(2)           |         |
| L2-L3                         | 4(8)       | 1(2)           |         |
| L3-L4                         | 7(14)      | 14(29)         |         |
| L4-L5                         | 12(24)     | 14(29)         |         |
| L5-S1                         | 14(28)     | 11(22)         |         |
| Prolapses, n (%)              | 38(75)     | 28(57)         | 0.07    |
| L1-L2                         | 2(4)       | 0(0)           |         |
| L4-L5                         | 22(43)     | 13(27)         |         |
| L5-S1                         | 21(41)     | 17(35)         |         |
| Nerve root compressions, n (%)| 38(75)     | 36(74)         | 0.44    |
| Central stenosis, n (%)       | 4(8)       | 2(4)           | 0.68    |
| Foraminal stenosis, n (%)     | 2(4)       | 2(4)           | 0.99    |
| Lateral recesses, n (%)       | 28(55)     | 29(59)         | 0.98    |
| L3                            | 2(4)       | 0(0)           |         |
| L4                            | 3(6)       | 3(6)           |         |
| L5                            | 20(49)     | 11(22)         |         |
| S1                            | 10(20)     | 16(32)         |         |
| Spondylolysis, n (%)          | 3(6)       | 0(0)           | 0.24    |
| Spondylolisthesis, n (%)      | 5(10)      | 4(8)           | 0.97    |

CEN = centralizers, Non-CEN = non-centralizers
Table 3
Comparison of disc degenerative changes on MRI between sciatica patients classified by the McKenzie method in the CEN- and the Non-CEN-groups (N=100).

|                          | CEN (n=51) | Non-CEN (n=49) | p-value |
|--------------------------|------------|----------------|---------|
| Spondylosis, n (%)       | 50(98)     | 42(86)         | 0.03    |
| Modic changes, n (%)     | 32(63)     | 21(43)         | 0.05    |
| Modic 1                  | 10         | 10             |         |
| Modic 2-3                | 22         | 11             |         |
| Disc degeneration degrees (Pfirrmann), mean (SD) | 12.8(3.5) | 10.6(3.8) | 0.003 |
| Disc degeneration degrees (Pfirrmann) yes, n (%) |
| L1-L2                    |            |                | 0.15    |
| 1                        | 25(49)     | 31(63)         |         |
| 2-3                      | 23(45)     | 17(35)         |         |
| 4-5                      | 3(6)       | 1(2)           |         |
| L2-L3                    |            |                | 0.005   |
| 1                        | 18(35)     | 31(63)         |         |
| 2-3                      | 29(57)     | 17(35)         |         |
| 4-5                      | 4(8)       | 1(2)           |         |
| L3-L4                    |            |                | 0.05    |
| 1                        | 13(25)     | 23(47)         |         |
| 2-3                      | 35(69)     | 23(47)         |         |
| 4-5                      | 3(6)       | 3(6)           |         |
| L4-L5                    |            |                | <0.001  |
| 1                        | 2(4)       | 11(22)         |         |
| 2-3                      | 22(43)     | 30(61)         |         |
| 4-5                      | 27(53)     | 8(16)          |         |
| L5-S1                    |            |                | 0.01    |
| 1                        | 2(4)       | 6(12)          |         |
| 2-3                      | 16(31)     | 23(61)         |         |
| 4-5                      | 33(65)     | 20(41)         |         |
| Total end-plate damage scores, mean (SD) | 12.0(3.5) | 10.1(3.8) | 0.01  |
| Total end-plate damage (TEP) scores yes, n (%) |
L1-L2

|   |   |   |
|---|---|---|
| 1-2 | 40(78) | 38(78) |
| 3-4 | 10(20) | 10(20) |
| 5-6 | 1(2) | 1(2) |

L2-L3

|   |   |   |
|---|---|---|
| 1-2 | 39(76) | 38(78) |
| 3-4 | 11(22) | 10(20) |
| 5-6 | 1(2) | 1(2) |

L3-L4

|   |   |   |
|---|---|---|
| 1-2 | 35(69) | 42(86) |
| 3-4 | 15(29) | 7(14) |
| 5-6 | 1(2) | 0(0) |

L4-L5

|   |   |   |
|---|---|---|
| 1-2 | 16(31) | 33(67) |
| 3-4 | 31(61) | 14(29) |
| 5-6 | 4(8) | 2(4) |

L5-S1

|   |   |   |
|---|---|---|
| 1-2 | 12(24) | 24(49) |
| 3-4 | 32(63) | 29(41) |
| 5-6 | 7(14) | 5(10) |

CEN = centralizers, Non-CEN = non-centralizers

Discussion

In this present study the MRI discogenic findings were high and the amount of disc contour changes were similar between the groups, as were nerve root compressions, central and foraminal stenosis, lateral recess and spondylolisthesis findings despite different clinical findings. Patients in the CEN-group had significantly higher disc degeneration scores (Pfirrmann's), more Modic changes and endplate damages, and more spondylosis on MRI than those in Non-CEN-group.

Diagnostic imaging and surgery may be indicated in patients with severe lumbar radicular symptoms who fail to respond to conservative care in 6-8 weeks [4]. In this present study, the mean duration of radicular pain was over three months before they were referred to tertiary hospital for further medical investigations. These patients had statistically similar sociodemographic data and neurological signs and symptoms, with two exceptions: the non-
centralizers had significantly stronger back pain and they were significantly more disabled than centralizers. There was no statistical difference in lower leg pain.

It has been shown that a single imaging finding such as Modic change or disc degeneration has only weak association with the presence of pain [20]. Modic changes at L5–S1 and Modic type I lesions are more likely to be associated with lower back pain and sciatica pain symptoms than other types of Modic changes or changes located at other lumbar levels [21]. In our analysis, the significant amounts of herniated discs, lateral recess findings, nerve root compressions, degeneration changes, Modic changes and total endplate damages were found mostly at L4-5 levels and secondly at L5-S1 levels. These different types of disc contours changes, other types of degenerative image findings and Modic changes on MRI are also highly prevalent in asymptomatic populations and increase with advanced age [8].

Albert et al. [22] found that among their sciatica patients the amounts of centralizers was as high as 85%. They concluded that no matter what type of disc lesion is found on MRI and despite the severity of leg pain and neurological findings; it was possible for the majority of this group of patients to demonstrate centralization [22]. In our analysis the CEN-group prevalence was much lower. The reason for which might be the difference in definition of centralization. In contrast to Albert et al. we did not include those patients in the CEN-group, if the centralization was unstable i.e., the pain was reduced or abolished during the repeated movements testing or positioning, but after resuming a weight bearing position for at least three minutes, the site and pain intensity level returned to the pre-testing location and intensity. In our study these patients were assigned into the Non-CEN-group.

To the best of our knowledge, our study may be the first to investigate the difference of the features of spinal discs and other degenerative changes on MRI between sciatica patients classified by repeated movements and sustained postures into centralizers and non-centralizers. The MDT system has acceptable inter-examiner reliability for classifying patients with back pain into subgroups when applied by therapists trained into the method [23]. In this study the physiotherapists who classified the patients were certified and experienced in assessing and classifying sciatica patients into different mechanical subgroups. However, the assessment and classification were based only on the first clinical examination at study entry, thus this may have affected the distribution of patients. Werneke et al. [24] found, that it may take up to seven therapy visits to define the exact group among chronic patients such as ours.

Another limitation might have been that the MRI morphology was not subjected to inter-examiner reliability assessment. Lurie et al. [25] concluded that classification of disc morphology showed substantial intra-and inter-reader agreement, whereas thecal sac and nerve root compression showed moderate reliability. In another study excellent agreement was found on the affected disc levels and nerve root that most likely caused the sciatica symptoms [1]. In this present study doctors who evaluated MR images were experienced in reading MR images and were blinded to the results of the clinical examination and classifications of patients.

In conclusion, this study provides a relationship of sciatica patients’ pain behavior classified by repeated movements and sustained postures with structural MRI findings. More progressed degenerative changes on MRI were found in the centralizers than in the non-centralizers. Disc contour changes on MRI were similar between patients in both groups as well as prevalence of disc herniation compressing a nerve root. Thus, neither disc nor overall degenerative findings in sciatica patients can be used to determine types of radicular pain.
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