Pain centralization and lumbar disc MRI findings in chronic low back pain patients  
Kilpikoski S, PT, PhD, Laslett M, FNZCP, PhD, Airaksinen O, MD, DMedSci, Kankaanpää M, MD, DMedSci, 
Alen M, MD, DMedSci 
Reprinted with kind permission from Manuelle Therapie (June 2011)

Background: Centralization of pain is a specific finding in assessing low back pain (LBP). A dynamic, internal "disc model" has been hypothesized as an underlying mechanism for pain centralization, which has shown a high positive correlation with pain during provocation discography. Structural abnormalities on MRI are also common among asymptomatic individuals, but association of centralization among symptomatic individuals to imaged disc pathology has not been evaluated.

Aims: To estimate the association (criterion-related validity) of the centralization phenomenon with magnetic resonance imaging (MRI) findings of lumbar disc pathology, as the criterion standard among chronic low back pain patients.

Methods: Randomly drawn volunteers (N=39) with non-specific LBP from a larger randomized controlled trial were clinically assessed for the presence of centralization by two physiotherapists using the McKenzie Method. MRI slices of patients' lumbar spines from L1 to S1 levels were acquired with a 1.5 Tesla superconducting magnet. Findings were recorded by an experienced radiologist. Validity was estimated with sensitivity, specificity, positive (PPV) and negative predictive values (NPV) and likelihood ratios.

Results: In the total sample, the prevalence of the MRI features most closely associated to pain was 82%, and among centralizers 94%. Sensitivity of centralization was 0.91, specificity 0.5, PPV 0.94; NPV 0.40, positive likelihood ratio 1.8 and negative likelihood ratio -0.18.

Conclusion: In this study, MRI showed that pain centralization is associated with abnormalities of lumbar discs. As the centralization phenomenon is closely associated with good treatment outcomes, we recommend centralization guided conservative treatment for disc pathologies before surgical referral.

Key Words: Low back pain, centralization phenomenon, MRI, McKenzie Method, discogenic pain.

Key Points: A dynamic internal “disc model” has been hypothesized as an underlying mechanism for centralization of low back pain. This cross-sectional study estimated the association of pain centralization with lumbar disc MRI findings. In this study MRI showed that pain centralization is associated with MRI findings of lumbar disc abnormality.

Introduction

Low back pain (LBP) is frequently accompanied by referred pain into the buttock or lower limb, unilaterally or bilaterally. Most commonly, this is somatic referred pain and less frequently, it is called radicular pain. Radicular pain is characterized by its sharp twinging, "lancinating" nature and somatic referred pain is characterized by its deep, diffuse aching character. It is not uncommon for patients to report that pain referred into the buttock and lower extremity may change location. Sometimes the pain refers as distally as the foot and at other times it is confined to the low back or buttlock areas. These changes in location are frequently associated with changes in posture or specific activities in a consistent manner, which suggests that mechanical loading in certain directions can affect the change (McKenzie and May 2003, Donelson et al 1991). McKenzie (McKenzie and May 2003) was the first clinician to report that specific repeated movement tests or sustained positions could consistently cause the movement of pain in a predictable and repeatable fashion. Centralization of pain is defined as “an abolition of distal limb symptoms in response to the deliberate application of repeated movements or sustained postures” (McKenzie and May 2003) (Appendix I). "Directional preference" is closely related to pain centralization, and indicates the direction of force required to centralize the pain (McKenzie and May 2003) (Appendix I). They are specific phenomena observed when LBP is assessed using standardized repeated end range test movements and are highly specific to positive provocation discography (Donelson et al 1997, Laslett et al 2005). The prevalence of centralization is estimated to be 70% among sub-acute and 52% among chronic back patients (Aina et al 2004). The younger the patient, the higher the prevalence rate of the centralization phenomenon (Werneke et al 2011). The inter-examiner agreement in determining centralization and identification of a “directional preference” has shown to be good between the trained examiners (Kilpikoski et al 2002), but poor between examiners with minimal or no training (Riddle et al 1993). Loading in the preferred direction centralizes and lessens symptoms, improves range of motion (Long et al 2004) and predicts good treatment outcomes (Werneke et al 2011, Long et al 2004, Skytte et al 2005). In contrast, loading in the opposite direction worsens or peripheralizes (McKenzie and May 2003) (Appendix I) the pain and makes movement more difficult (Riddle et al 1993). A dynamic internal “disc model” has been hypothesized as the underlying mechanism for these phenomena and may be explained by changes in disc displacement (Kolber and Hanney 2009).

Magnetic resonance imaging (MRI) is a non-invasive method for investigating lumbar morphology (Milette et al 1999). A key limitation of spinal imaging is non-systematic association with pathology and symptoms (Hamanishi et al 2004, Beattie et al 1994). Abnormal morphology may be found in individuals who have no symptoms and vice versa (Milette et al 1999, Hamanishi et al 2004, Beattie et al 1994).
Images, as such, have little value in identifying symptomatically significant abnormal morphology and should not be used for diagnosis or treatment planning out of context from the patient’s clinical presentation in most cases (Milette et al 1999, Hamanishi et al 2004). However, MRI features of discs, most closely associated with pain, include disc herniation (Jensen et al 2008), disc narrowing (Jensen et al 1994, Videman et al 2003), radial fissures (Jensen et al 1994, Hassett et al 2003), especially when they reach the disc exterior and leak (Moneta et al 1994), and internal disc disruptions, including inward collapse of the annulus (Videman and Nurminen 2004). A high intensity zone (HIZ) on T2 weighted images in the posterior annulus has also shown to have high specificity in relation to provocation discography in some studies (Schwarzer et al 1995, Aprill and Bogduk 1992).

More variability related to pain was end-plate fractures, Schmorl’s nodes (Beattie et al 1994), Modic (type II) changes (Jensen et al 2008) and disc bulging (Beattie et al 1994, Jensen et al 2008, Jensen et al 1994, Videman et al 2003, Boos et al 1995). Disc signal intensity on MRI has little or no relationship to pain (Videman et al 2003).

The purpose of this study was to investigate the association of centralization with MRI features of discs most closely associated with lumbar pain as the “criterion standard” in chronic LBP patients.

Methods

Procedure

The present article is a secondary analysis of data from a larger cross-sectional study carried out at Kuopio University Hospital, Finland. The imaging and clinical data were gathered during the years 1997 and 1998, and this secondary analysis ten years later aims to test for possible association between centralization phenomenon and disc abnormalities revealed by MRI (Kilpikoski, Kankaanpää et al 1999). Volunteers with non-specific LBP, with or without radiation to the lower limb, were included. Patients were randomly drawn from a previously described randomized controlled trial (Kankaanpää et al 1999). The subjects were initially randomized into their rehabilitation groups by drawing lots before coming to the rehabilitation clinic for the baseline measurements. In the draw, paper slips stating the subject’s name, sex, and age were first separated according to gender and then placed into two large bowls, shuffled, and drawn forming the treatment groups in a blinded manner. In the initial health centre-based clinical examination, the cause of back pain was confirmed to be nonspecific. The patients had experienced LBP with symptom duration longer than three months and moderate functional disability that enabled them to work with only occasional absences. The exclusion and inclusion criteria of the wider trial have been described elsewhere (Kankaanpää et al 1999).

Radiological methods

Magnetic resonance images were acquired using a Siemens Magneton SP4000 with a 1.5 Tesla superconducting magnet (Magnetom Vision Siemens AG, Germany). Images were acquired with patients lying supine with knees slightly bent, maintained with a cushion. Axial and sagittal T1 and T2 weighted images were acquired for the spinal levels from L1 to L5. Images were analyzed by a radiologist at Kuopio University Hospital, Kuopio, Finland. MRI features of discs most closely associated with pain (disc bulges, disc protrusions, disc protrusions/extrusions, radial fissures, end-plate signal changes, disc space narrowing and internal disc disruptions such as high intensity zones) were documented.

Clinical examination

The patients were examined independently in the year 1997-1998, in succession, by two physical therapists (Päivi Leminen and Sinikka Kilpikoski) certified in the McKenzie Method. The clinical examination has been described previously (Videman et al 2003). Briefly, the examination included visual assessment of range and quality of motion, recording anatomical location of dominant pain, nerve tension tests, key muscle strength tests, light touch sensitivity, the standardized test single and repeated end range test movements and/or sustained end range positions described by McKenzie (McKenzie and May 2003).

Testing for centralization

During the mechanical assessment, the exact site and change in location of low back and referred pain was recorded. The patient was classified as a centralizer, if pain was found to move from the periphery towards the spinal midline, and remained more central in response to a specific direction of testing. If there was midline spine pain only, and this was abolished and remained so, this was also classified as centralization (McKenzie and May 2003) (Appendix I). If patients were symptom free or if no change in the location of pain was observed (i.e. dysfunction syndrome), or pain was found to move only towards periphery (peripheralization) (McKenzie and May 2003) (Appendix I) during assessment, the participants were classified into the non-centralization group. The movements and positions used to determine centralization are highly standardized and consist of standing flexion, standing extension, side gliding in standing to the left and right (a form of lateral flexion), supine flexion, prone extension, asymmetric prone lumbar extension, and lumbar rotation performed in supine (McKenzie and May 2003) (Appendix I). The trial flow is seen in Figure 1.

Blinding

The examiners conducting the clinical assessment in test-retest manner were blinded from each other and to the results of imaging findings. The radiologist was blinded to the results of the clinical examination and classifications.
Pain centralization and lumbar disc MRI findings in chronic low back pain patients

Ethics
The study was approved by the Kuopio University Hospital Human Ethics Committee.

Data analysis
The demographic characteristics were summarized for descriptive purposes with means and standard deviations for continuous measures, with frequencies and percentages for categorical measures. Inter-examiner reliability statistics were calculated using the DAG Stat Excel spreadsheet.

The criterion-related validity was analyzed in 2x2 contingency tables using Confidence Interval Analysis Software (Bryant 2004), and was expressed as sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios with confidence intervals (Bogduk 1999). The data were stored and analysed using SPSS Version 14.0.

Results

Participants
Patients' descriptive characteristics are presented in Table 1. One centralizer was excluded from the 2x2 contingency table because he was not imaged.

Identification of centralization
Table 2 presents the numbers and percents requiring the different movement and loading strategies found to produce the centralization phenomenon.

Inter-examiner reliability of identification of centralization
Table 3 presents the contingency table with data obtained in the estimation of inter-examiner reliability between the two blinded examiners. The examining clinicians agreed on centralization in 34 cases (87%, $\kappa=0.72$ (CI95%: 0.41-1.0)). SE of Kappa =0.192. Observed agreement was 0.95 (95%CI 0.83-0.99), chance agreement was 0.82. Prevalence and bias adjustment (PABAK) calculation was 0.90. Two patients were agreed to be symptom free and one to have non-centralizing pain. The examiners disagreed in classifying two patients (Kilpikoski et al 2002).

Magnetic resonance imaging
The patients (N=38) were imaged between one to five times (mean three) during a three month period (mean 56 days, range 0-195 days) before the clinical assessment. Most patients (n=20, 61%) were imaged less than two weeks prior to the clinical assessment (mean six days, range 0-13 days).

Structural abnormalities on MRI among the agreed centralizers (n=33)
Twenty-eight (85%) centralizers had alterations of disc shape contour in least at one spinal level in conjunction with disc space narrowing mostly at L3 to L5 levels. Only one centralizer, with right sided referred pain below the knee, had no visible structural abnormalities on MRI. In addition, one patient had increased signal intensity (high intensity zone) at the L1 level, with left sided referred pain below the knee. Seven (21%) patients had end-plate signal changes (Modic changes) and thirty-one (94%) patients had disc signal loss. Half (n=16) of the patients had anatomic defects such as stenosis, anterolisthesis, retrolisthesis, and/or zygapophyseal joint osteoarthritis. Most of these defects (65%) were found between L3 and L5 levels (Table 2).

Criterion-Related Validity
The prevalence of discogenic MRI findings was 82% in total sample, and 94% among the agreed on centralizers, and 9% in non-centralizers or none agreed-on centralizers. Features of discs most closely associated with pain on MRI (i.e. alterations of disc shape contour, disc narrowing, high intensity zone and endplate changes) were concatenated into a single variable. Criterion-related validity of centralization in relation to the combined MRI findings group was:

- sensitivity 0.91 (95% CI 0.8-0.96),
- specificity 0.5 (95% CI 0.018-0.82),
- PPV 0.94 (95% CI 0.83-0.98),
- NPV 0.40(95% CI 0.14-0.73),
- positive LR+1.8 (95% CI 0.8-4.2)
and negative LR-0.18 (95%CI 0.05-0.6) (Table 4).

Discussion
This secondary analysis aimed to estimate the criterion-related validity of the centralization phenomenon in relation to the MRI features of discs most closely associated with pain. Criterion-related validity measures how well a test performs against a criterion standard, and is expressed by sensitivity, specificity, positive and negative predictive values and with likelihood ratios (+/-). Centralization has previously been shown to be highly specific to positive discography (Donelson et al 1997, Laslett et al 2005). Discography specifically aims to identify symptomatic discs whereas MRI imaging identifies anatomical and morphologic features, thus the MRI findings do not directly test to determine the source of pain. The results of our study are not directly comparable to these previous studies (Donelson et al 1997, Laslett et al 2005) because the reference standards are quite different. For providing meaningful and reliable judgements of classifying the centralization phenomenon, the inter-examiner variability between the physical therapists certified in the McKenzie Method was tested before the criterion-related validity comparison (Kilpikoski et al 2002). The inter-examiner agreement was similar to other inter-examiner studies among trained observers (Razmjou et al 2000, Clare et al 2005). In our study, the prevalence of centralization agreed by both examiners was 85%, being somewhat higher than in earlier published studies among LBP patient samples (Aina et al 2004). However, high prevalence rates of centralization were also found in some earlier studies (Donelson et al 1991, Aina et al 2005).
Pain centralization and lumbar disc MRI findings in chronic low back pain patients

2004, Razmjou et al 2000), especially among young (18-44 years) patients (83%) (Werneke et al 2011). The mean age of our population was 40 years. One explanation for the difference might be that centralization was defined only once by both examiners on the first visit, on the same day, whereas, in earlier studies (Aina et al 2004) the centralization was defined by testing during multiple visits. The high sensitivity of pain centralization makes it possible to effectively rule out pain related MRI findings being observed in the absence of centralization. The repeated movements assessment of the McKenzie Method is an inexpensive and efficient screening tool in selecting patients unlikely to have pain related MRI findings.

Limitations of the present study
A good test is one which carries a few, if any, false positive and false negative results (Bryant 2004). In our study there were a few false positives numerically, but there were also few cases without MRI changes resulting in specificity equivalent to random guessing (specificity =0.5) (Table 4). This does not mean that these centralizers did not have discogenic pain. Perhaps the morphological features of disc mechanics associated with centralization were not demonstrated by MRI in these cases. The false negative value, which describes how often patients without the measured condition are positive for the test in question (Bogduk 1999), was quite low in the present study. Examiners disagreed in classifying two patients with alterations of disc shape contour on MRI. Abnormal morphology on MRI may be found also in asymptomatic individuals (Milette et al 1999, Hamanishi et al 2004, Beattie et al 1994, Jensen et al 2008, Jensen et al 1994, Videman et al 2003) and indeed one patient, who was totally symptom free at the time of clinical assessment, had a bulging disc at L5 spinal level. In this present study, only one LBP patient (2%), with centralizing pain, had no visible imaging findings. This compares with the average rates of the studies of asymptomatic population 36% (Beattie et al 1994) and from 40% to 65% (Jarvik et al 2001). In addition, the prevalence rate of discogenic abnormalities most closely associated with pain (94%) and the alterations of disc shape contour among centralizers in our study were higher (85%) than shown in average in the studies of asymptomatic subjects: from 24% (Razmjou 2000) to 64% (Jarvik et al 2001).

One major limitation of this current study was the small study size. In addition, the small groups of non-centralizers (n=5) and those with no MRI findings (n=4) resulted in wide confidence intervals for specificity, NPV and the likelihood ratios. Consequently, only tentative conclusions are reasonable. The results are strengthened by the fact that the patients were randomly drawn from a larger randomized controlled trial. In addition, the relatively long time period between the imaging and the clinical assessment might compromise the results. The advantage of this study was the multiple imaging (mean three times) during the on-going wider study. No statistically significant changes were found between the imaging findings in multiple comparisons. The radiologist was blinded to the results of the clinical examination and classifications. However, the radiologist’s determination of MRI morphology was not subjected to inter-examiner reliability assessment.

This study provides some preliminary evidence of a relationship between the clinical phenomenon of lumbar back pain centralization and structural MRI findings. MRI is inherently an image of structural status, at a specific point in time, i.e. it is a static image; whereas, centralization is a phenomenon of a dynamic process during which pain location is closely monitored. Future studies using modern MRI images before and after mechanical assessment for the presence of centralization may reveal correlations with pain centralization and changes in disc shape. In this manner, the ‘dynamic disc model’ could be examined in a more specific and comprehensive manner.

Conclusions
Our study supports the view that the centralization phenomenon is associated with abnormalities of lumbar discs, but the abnormalities may not differ much from those of an asymptomatic population. As the centralization phenomenon is closely associated with good treatment outcomes, we recommend centralization-specific direction al therapy before referral to surgical intervention in cases with MRI findings of disc pathology.

References


Pain centralization and lumbar disc MRI findings in chronic low back pain patients


Appendix I
Definitions and operational terms used in the study

**Centralization Phenomenon:** Describes the phenomenon by which distal limb pain emanating from, although not necessarily felt, in the spine is immediately or eventually abolished in response to the deliberate application of loading strategies. Such loading causes an abolition of peripheral pain that appears to progressively retreat in a proximal direction. As this occurs, there may be a simultaneous development or increase in proximal pain.

**Peripheralization:** Describes the phenomenon when pain emanating from the spine, although not necessarily felt in it, spreads distally into, or further down, the limb. This is the reverse of centralization. In response to repeated movements or a sustained posture, if pain is produced and remains in the limb, spreads distally or increases distally, that loading strategy should be avoided.

**Directional preference:** Describes the phenomenon of preference for postures or movement in one direction, in which the centralization phenomenon occurs. It describes the situation when postures or movements in one direction decrease, abolish or centralise symptoms and often increase a limitation of movement. Postures or movements in opposite direction often cause these symptoms and signs to worsen. This does not always occur, and may be a product of the length of exposure to provocative loading.

**Lumbar extension:** In standing by bending the trunk backwards; and in prone lying by passively raising the trunk, using the arms instead of the back muscles and at the same time keeping the pelvis down. Both manoeuvres cause extension of the lumbar spine from above downwards.

**Lumbar extension with hips off centre:** Extension in lying with hips off centre is needed if testing is inconclusive and pain unilateral asymmetrical. Hips are placed off centre, away from the side of pain and then extension in lying is repeated.

**Lumbar flexion:** In standing by bending the trunk forwards and in supine lying by using the hands to passively bend the knees onto the chest. In flexion in lying, the flexion takes place from below upwards, the L5-S1 join moving first followed by flexion in turn of each successively higher segment. In flexion in standing, the flexion occurs from above downwards.

**Side-gliding:** This movement takes place when the patient laterally displaces his or her shoulders, relative to the pelvis. This movement is different from side-bending because the shoulders remain parallel to the ground. While the patient is in the standing position side-gliding to right takes place when patient’s shoulders are gliding to right in relation to the pelvis in the frontal plane viewed from behind (C7-S1).

**Rotation in flexion:** When rotation of the lumbar spine is achieved by using the legs of the patient as a lever or fulcrum of movement, confusion arises as to the direction in which the lumbar spine rotates. This is judged by the movement of the upper vertebrae in relation to the lower- for example if the patient is lying supine and the legs are taken to the right, then the lumbar spine rotates to the left.
Pain centralization and lumbar disc MRI findings in chronic low back pain patients

Figure 1. Flow chart of the trial
Pain centralization and lumbar disc MRI findings in chronic low back pain patients

Table 1.
Characteristics of the population on clinical assessment day (N=39)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Non-specific LBP patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean years, range)</td>
<td>40 (24-55)</td>
</tr>
<tr>
<td>Gender (number of females/males)</td>
<td>15/24</td>
</tr>
<tr>
<td>Duration of low back trouble (mean years, range)</td>
<td>14 (1-38)</td>
</tr>
<tr>
<td>Number of previous episodes:</td>
<td></td>
</tr>
<tr>
<td>1-5 episodes, n (%)</td>
<td>16 (41)</td>
</tr>
<tr>
<td>6-10 episodes, n (%)</td>
<td>7 (18)</td>
</tr>
<tr>
<td>&gt;10 episodes, n (%)</td>
<td>16 (41)</td>
</tr>
<tr>
<td>Duration of current episode of LBP:</td>
<td></td>
</tr>
<tr>
<td>(on the day of McKenzie clinical assessment)</td>
<td></td>
</tr>
<tr>
<td>Symptom-free, n (%)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Acute: &lt;7 days, n (%)</td>
<td>5 (13)</td>
</tr>
<tr>
<td>Sub-acute: &gt;7 days &lt; 7 weeks, n (%)</td>
<td>9 (23)</td>
</tr>
<tr>
<td>Chronic: &gt;7 weeks, n (%)</td>
<td>23 (59)</td>
</tr>
<tr>
<td>Symptom location:</td>
<td></td>
</tr>
<tr>
<td>Symptom-free n (%)</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Low back pain only n (%)</td>
<td>7 (17)</td>
</tr>
<tr>
<td>Radiating pain to thigh n (%)</td>
<td>21 (55)</td>
</tr>
<tr>
<td>Radiating pain below the knee n (%)</td>
<td>3 (8)</td>
</tr>
<tr>
<td>Radiating pain below the knee with neurological signs n (%)</td>
<td>6 (15)</td>
</tr>
</tbody>
</table>

Table 2.
Directions of loading producing the centralization phenomenon and the MRI findings at different spinal level from L1 to L5 among agreed-on centralizers (N=33)

<table>
<thead>
<tr>
<th>Direction of loading:</th>
<th>Discogenic findings* in MRI</th>
<th>Other abnormalities* in MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar extension (21%, n=7)</td>
<td>L1: Bulge (1), Extr (1)</td>
<td>L1: Retro (1)</td>
</tr>
<tr>
<td></td>
<td>L2: Bulge (2), Narrowing (2)</td>
<td>L2: Retro (1)</td>
</tr>
<tr>
<td></td>
<td>L3: Bulge (3), Prot (2), Narrowing (7)</td>
<td>L3: Stenosis (1), Facet (1)</td>
</tr>
<tr>
<td></td>
<td>L4: Bulge (5), Prot (2), Narrowing (14)</td>
<td>L4: Retro (2), Stenosis (6), Facet (4)</td>
</tr>
<tr>
<td></td>
<td>L5: Bulge (5), Prot (2), Narrowing (14)</td>
<td>L5: Antero (2), Stenosis (2), Facet (3)</td>
</tr>
<tr>
<td>Lumbar extension with hips off centre or side-gliding forces (73%, n=24)</td>
<td>L1: Bulge (1), Extr (1), HZ (1), Narrowing (4)</td>
<td>L1: Facet (1)</td>
</tr>
<tr>
<td></td>
<td>L2: Bulge (2), Narrowing (3)</td>
<td>L2:</td>
</tr>
<tr>
<td></td>
<td>L3: Bulge (3), Prot (2), Extr (2), Narrowing (7)</td>
<td>L3: Stenosis (1), Facet (1)</td>
</tr>
<tr>
<td></td>
<td>L4: Bulge (3), Prot (7), Extr (3), Narrowing (14)</td>
<td>L4: Retro (2), Stenosis (6), Facet (4)</td>
</tr>
<tr>
<td></td>
<td>L5: Bulge (5), Prot (2), Extr (4), Narrowing (14)</td>
<td>L5: Antero (2), Stenosis (2), Facet (3)</td>
</tr>
<tr>
<td>Rotation in flexion followed by lumbar extension (6%, n=2)</td>
<td>L1: Bulge (1)</td>
<td>L1:</td>
</tr>
<tr>
<td></td>
<td>L2: Bulge (1)</td>
<td>L2:</td>
</tr>
<tr>
<td></td>
<td>L3: Bulge (1), Extr (1), Narrowing (2)</td>
<td>L3:</td>
</tr>
<tr>
<td></td>
<td>L5: Prot (1), Narrowing (1)</td>
<td>L5:</td>
</tr>
</tbody>
</table>

*Bulge = a bulging disc, Prot = protruded disc, Extr = extruded disc, Narrowing = disc space narrowing, HZ = high intensity zone, Retro = retrolisthesis, Antero = anterolisthesis, Stenosis = foraminal or spinal stenosis, Facet = zygapophyseal joint arthritis
Pain centralization and lumbar disc MRI findings in chronic low back pain patients

Table 3.
The 2 x 2 contingency table of data used to calculate inter-examiner reliability of identification of the centralization phenomenon (N=39)

<table>
<thead>
<tr>
<th>Examiner 2</th>
<th>Centralization Phenomenon (CP)</th>
<th>CP +</th>
<th>CP -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examiner 1</td>
<td>CP +</td>
<td>34</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CP -</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: Kappa coefficient = 0.72 (CI95% 0.41-1.0). SE of Kappa 0.192

Table 4
The 2 x 2 contingency table comparing “centralizing or non-centralizing pain” with features of discogenic pain such as bulged, protruded, prolapsed/extruded discs, disc space narrowing and disc disruptions (HIZ) on MRI among LBP patients (N=38)

<table>
<thead>
<tr>
<th>Centralizing pain</th>
<th>Features of discogenic pain on MRI</th>
<th>Features of discogenic pain on MRI</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (+)</td>
<td>No (-)</td>
<td></td>
</tr>
<tr>
<td>Yes (+)</td>
<td>31</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>No (-)</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td>34</td>
<td>4</td>
<td>38</td>
</tr>
</tbody>
</table>

Notes:
Sensitivity 0.91(0.8-0.96)
Specificity 0.50(0.18-0.82)
PPV 0.94(0.83-0.98)
PNV 0.40(0.14-0.73)
+LR 1.8(0.8-4.2)
-LR 0.18(0.05-0.6)