Association of low back pain with Modic changes and other degenerative changes of lumbar spine in middle aged working men: a cross-sectional MRI study

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Aims and objectives

The association of nonspecific low back pain (NSLBP) with degenerative disc changes and bony endplate lesions is still not clear. In an earlier cross-sectional MRI study (on 0.01T) of 164 middle-aged, 40-45 years old, working men (construction workers, machine drivers and office workers), the number of posterior and anterior bulges and discs with decreased signal intensity of nucleus pulposus was found to have an association with LBP and posterior bulges with radiating pain even when possible confounding factors (occupation, trauma, BMI, smoking) were controlled [1]. Also genetic effects have been suggested to explain LBP [2]. Modic type subchondral signal abnormalities in bone marrow have been shown to have a stronger association with LBP than many other degenerative MRI changes[3]. Bony endplate lesions have been found to associate with lifetime LBP [4].

Bony endplate defects and irregularities have been shown to develop relatively fast along with disc desiccation and with changing Modic 1 type degenerative subchondral signal abnormalities as they turn into Modic 2 type [5-7]. In this cross-sectional MRI study, degenerative subchondral signal changes and bony endplate lesions were assessed in detail, in addition to degenerative disc changes. The aim was to clarify the association of degenerative disc and bony endplate changes and spondylolisthesis with severity of LBP during the preceding 7 days, 12 months and 4 years.
Methods and materials

Subjects in this study are a subgroup of the earlier cross-sectional study of 164 middle-aged (40-45 year old) men described above [1]. 145 men with a sufficient image quality of their lumbar spine MRI (0.01T) studies were accepted. T2- and PD- weighted sagittal images (Dual Echo 2000/25-86, 2 acquisitions, 7mm slice thickness, pixel size 1.6x1.6mm) and two sets of T1- weighted GE coronal images (partial saturation 175/25, 1 acquisition, 5mm slice thickness, pixel size 1.4mm) were obtained.

The prevalence of Modic 1 and 2 type subchondral signal abnormalities was assessed by two experienced neuroradiologists in consensus. The prevalence of bulge (posterior bulging, protrusion or extrusion>3mm on sagittal image), annular tear, decreased signal intensity (SI) of nucleus pulposus (on T2WI) and height of the disc, bony endplate defect or irregularity and spondylolisthesis (>3mm) was assessed and graded according to criteria presented earlier [8-9]. In case of disagreement, the milder grade of degeneration was used as the final grade. In case the evaluation was not considered reliable it was graded as "missing". 119 of the men had complete questionnaire data and MRI assessment for each disc space. Examples of grading the degenerative findings are presented in the reference image (at 1.0T) (Figure 1) and in the T1-weighted coronal image (Figure 2)

Data on different types of LBP symptoms was obtained with a questionnaire and an interview.

- The severity and duration of LBP symptoms was questioned during preceding 7 days.

- The frequency and duration of LBP, intensity of LBP (on scale 0-100) and degree of disability caused by LBP (on scale 0-100) was questioned during preceding 12 months.

- The frequency and duration of LBP was questioned during preceding 4 years.

Severity of each graded or scaled (0-100) LBP variable was correlated (Spearman's rho) with the number of affected disc spaces, separately for each type of MRI finding.
Images for this section:

Fig. 1: In this T2-weighted reference image (at 1.0T), Modic 1 type subchondral signal abnormality is present in vertebral bodies L5 and S1 anteriorly, adjacent to L5/S1 disc. A bony endplate defect is present adjacent to the upper anterior endplate of disc L5/S1. Height of disc L5/S1 is decreased and its signal intensity is clearly decreased posteriorly but increased anteriorly. Discs L5/S1 and L4/L5 have a visible posterior annular tear. Discs L2/L3-L5/S1 show a posterior bulge and discs L2/L3 and L3/L4 show a decreased signal intensity.

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Fig. 2: In this T1-weighted image (at 0.01T), Modic 2 type subchondral signal abnormalities are detectable adjacent to upper and lower endplate of L3/L4 disc, two on the right and one on the left. In addition, a bony endplate defect is present in the vertebral body L3 on the right, adjacent to the L3/L4 disc.

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Results

13 subjects had one or more Modic 1 lesions and 43 Modic 2 lesions. Modic 1 associated only with LBP during preceding 12 months (Table1). Modic 2 associated with each LBP variable and bony endplate lesion with LBP during preceding 7 days or 12 months. Other degenerative findings, except annular tear, also associated with LBP variables. Bulges correlated stronger with 4 year than 12 months LBP and decreased disc height and SI strongest with disability causing 12 months' LBP. Spondylolisthesis associated only with disability causing LBP during 12 months (0.184, p=0.028). Most degenerative variables associated with each other.
Table 1. Correlation between number of discs with degenerative MRI finding and severity of LBP symptoms during preceding 7 days, 12 months and 4 years, among 145 working 40-45-year old men. (Spearman’s rho).

<table>
<thead>
<tr>
<th>LBP type and recall</th>
<th>Modic 1</th>
<th>Modic 2</th>
<th>Endplate lesion</th>
<th>Disc bulge</th>
<th>Disc height</th>
<th>Decreased SI of disc</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBP 7 days</td>
<td>0.104</td>
<td>0.237</td>
<td>0.214 0.014</td>
<td>0.197 0.021</td>
<td>0.203 0.015</td>
<td>0.230 0.006</td>
</tr>
<tr>
<td>LBP 12 months</td>
<td>0.221</td>
<td>0.011</td>
<td>0.275 0.001</td>
<td>0.286 0.001</td>
<td>0.217 0.009</td>
<td>0.163 0.053</td>
</tr>
<tr>
<td>Disability by LBP</td>
<td>0.072</td>
<td>0.411</td>
<td>0.312 0.000</td>
<td>0.178 0.037</td>
<td>0.363 0.000</td>
<td>0.330 0.000</td>
</tr>
<tr>
<td>LBP Intensity</td>
<td>0.048</td>
<td>0.584</td>
<td>0.320 0.000</td>
<td>0.174 0.042</td>
<td>0.265 0.001</td>
<td>0.205 0.015</td>
</tr>
<tr>
<td>LBP 4 years</td>
<td>0.029</td>
<td>0.746</td>
<td>0.220 0.013</td>
<td>0.087 0.324</td>
<td>0.310 0.000</td>
<td>0.165 0.055</td>
</tr>
</tbody>
</table>

Fig. 3

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Conclusion

Several degenerative MRI findings (Modic 2, endplate lesions, disc bulge and height) were associated with recent (7 days) LBP and all with 12 months LBP. Modic 1 or bony endplate lesions were not associated with 4 years LBP and Modic 2 correlated weaker with 4 years than 12 months LBP. This may suggest that Modic lesions turn into a less painful type with years. Modic 1 lesions were found to turn into Modic 2 type during 18-72 months follow-up in an earlier study of chronic LBP patients [5]. However, the correlation coefficients concerning any single MRI finding were modestly low in this study. Also the 4 years retrospective recall of symptoms may be less reliable than recall of 12 months symptoms.

A meta-analysis on the natural course of LBP symptoms in randomized clinical trials and observational cohort studies applied to primary care setting showed a rapid improvement in the first 6 weeks followed by a smaller further improvement until 52 weeks [10]. The current material was a cross section of working men representing different occupational groups and therefore not comparable to clinical patients. In a prospective MRI study of chronic LBP patients 45% of the Modic 1 lesions had enlarged during 1-year follow-up [7]. The small number and size of Modic 1 lesions may explain that association with recent (7 days) LBP was not found. A weaker effect of such small Modic 1 lesions on LBP symptoms may be expected than in LBP patients with larger lesions. The finding of most degenerative disc changes having an association with LBP is in line with the earlier follow-up study of LBP patients [11]. Our results are also in line with the cross-sectional MRI study of 40-year old subjects [3].

In addition to Modic type subchondral signal abnormalities, bony endplate lesions proved to have an association with recent and 12 months LBP, which is in line with a recent cadaver study [4]. In an earlier study of chronic LBP patients with Modic 1 lesion the degenerative disc changes and bony endplate defects were found to increase or progress along with enlarging or changing Modic 1 lesions (and appearance and enlargement of Modic 2 lesions) suggesting an accelerated degenerative process [6-7].

Our study was conducted with a low field MRI and thus has a restricted sensitivity. E.g. annular tear may be difficult to detect in low field MR images. The MRI findings were systematically recorded. Since retrospective questionnaire was used for grading symptoms, recall bias may affect the results. An advantage is that all subjects were men and their age variation was low.
Modic changes, but also bony endplate defects and degenerative disc changes, are important explanatory factors for LBP. Since they associate with each other, they may be part of a progressing degenerative process.
Personal information

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