Disc degeneration and lumbar instability

Magnetic resonance examination of 16 patients

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Flexion and extension radiographs of 75 young males with low back pain disclosed abnormal segmental motion of the lumbar spine in 16 patients with translational movements in 20 intervertebral segments. These 16 patients were further investigated by magnetic resonance imaging to assess disc degeneration in the unstable segments. On T2-weighted images of the 20 segments, the disc was normal in 13 and degenerated in only 7 patients. Thus, the initial factor in lumbar instability in young patients with low back pain is not always degeneration of the disc.

When the nucleus pulposus loses its normal turgor and stiffness from degeneration, abnormal segmental motion may occur (Knutsson 1944, Morgan and King 1957). Both clinical and cadaver studies suggest that a degenerated disc is associated with increased coupling movements and disc shear (Farfan 1980, Stokes et al. 1981). However, the initial mechanisms causing segmental instability are unclear; it is not known whether disc degeneration is a primary cause or a secondary result of instability.

Magnetic resonance (MR) imaging is more sensitive than discography in the diagnosis of early disc degeneration (Modic et al. 1984, Jenkins et al. 1985, Gibson et al. 1986, Schneiderman et al. 1987). MRI demonstrates pathologic changes related to tissue water content. At degeneration the disc undergoes a gradual loss of water and proteoglycan, and an increase in the keratin/chondroitin sulfate ratio (Lyons et al. 1981). We investigated whether unstable lumbar motion detected by flexion-extension radiographs always is associated with pathologic disc dehydration according to MR imaging.

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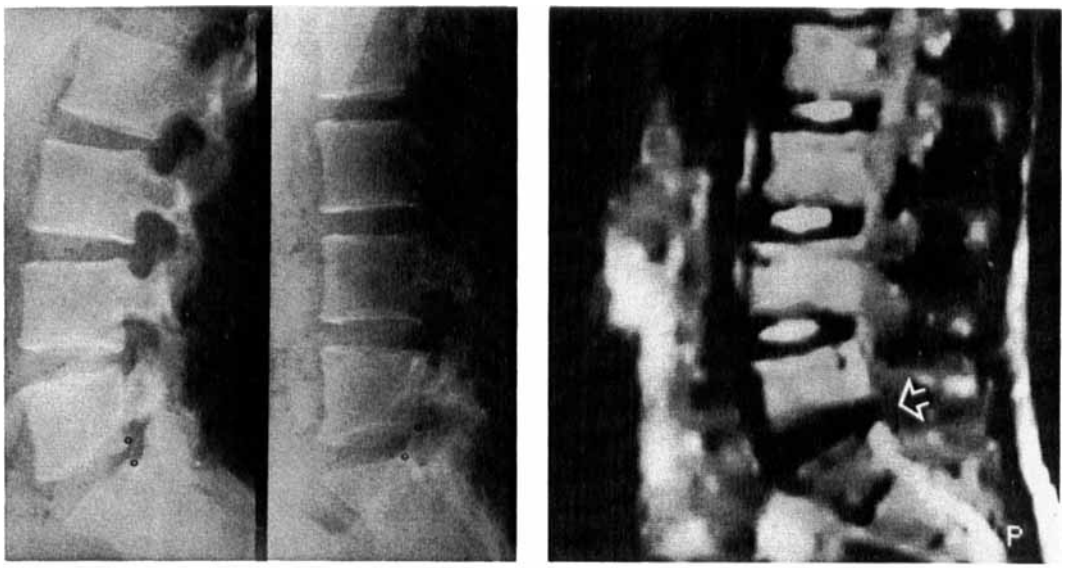
Patients and methods

All 75 patients were male conscripts referred to the Central Military Hospital of Helsinki for low back pain; only 13 had sciatica. The patients were examined by routine lumbosacral radiographs including upright flexion-extension projections. Sixteen patients with radiographically verified instability were selected for MR imaging. The neurologic examination of all the 16 patients was normal. The duration of pain exceeded 6 months in 14 cases; in only 2 patients was it less than 2 months. The mean age, height, and weight were 20 ± 1.0 years, 180 ± 5 cm, and 75 ± 11 kg, respectively. The control subjects comprised 34 asymptomatic male volunteers of the same age. The mean height and weight of the controls were 180 ± 6.9 cm and 74 ± 10 kg, respectively. There was no previous history of low back pain in the control group. Only MR imaging was performed in the control group.

Radiography

The supine patient was asked to perform maximal extension and flexion of the lumbar spine. In maximal extension the patient stood supporting himself with the buttocks on the edge of the table to stabilize the pelvis (Knutsson 1944). The radiographic landmarks of segmental motion were the uncinate processes. The movement between two adjacent lumbar vertebrae 3 mm or more was considered as pathologic instability (Dupuis et al. 1985). The radiographs were blindly evaluated by



A B

Figure 1. Flexion-extension radiographs (A) of a patient with low back pain and lumbar instability. The shear was 5 mm in the L5–S1 space. The T2-weighted (SE 1000/100) MR image (B) indicates that the nucleous pulposus of the L1–L5 spaces is normal (high-intensity signals). Disc dehydration is seen in the unstable presacral space (absence of MR signal, arrow).

3 radiologists. A disc at the levels of L1–L5 was considered narrowed if the height was less than that of the disc above. Only the L5–S1 disc space was allowed to be narrower than the space above without considering it to be degenerated.

Magnetic resonance imaging

The MR equipment (Acutscan, Instrumentarium, Finland) has a resistive magnet that operates at a field strength of 0.02 tesla (Agartz et al. 1987). The slice thickness was 10 mm and the imaging matrix 256 x 128. The field of view of the spine coil was 30 cm and the pixel size 1.2 x 2.4 mm. Both SE 1000/100 ms (T2-weighted) and SR 120/30 (T1-weighted) multislice high-resolution images were obtained sagitally to include the entire lumbar spine. MR imaging was performed in the afternoon.

The intensity of each intervertebral disc on the T2-weighted images was measured using the region-of-interest facility. In each patient there was at least one normal-appearing disc with a high MR signal intensity. This intensity was assigned the arbitrary value 1.0. The degree of disc degeneration was assessed by the signal intensity relative to this value. Signal intensity from 0.80 to 1.0 was considered normal, since the standard deviation of the intensity of normal discs was ± 0.10 (n 50). When the region-of-interest measurements gave a signal intensity of the nucleus pulposus from 0.60 to 0.79 of maximum (intermediate degeneration), a faint bright signal was seen in the abnormal disc. When the signal intensity was reduced below 0.60 (marked degeneration), a total absence of high-intensity nucleus pulposus was observed.

Results

Radiographic examination

Among the 16 patients with lumbar pain and radiographic instability, a total of 20 motion segments were recorded as unstable. The mean shear in the unstable segments at extension and flexion was 3.5 ±0.7 mm (mean ± SD, n 20). One segment was unstable at the L2–L3 level, five at L3–L4, 10 at L4–L5, and four at L5–S1. In 18/20 the displacement was such that the overlying vertebra was retroposed on extension of the spine and returned to its normal position on flexion. Lateral and anteroposterior radiographs revealed no signs of facet joint arthrosis in the unstable segments. Other findings included spina bifida of S1 in 4 patients, transitional fifth vertebrae in 3 patients, narrowed disc spaces in 4 patients, spondylolisthesis of L5 in 4 patients, and morbus Scheuermann in 2 patients.

Magnetic resonance examination

Disc degeneration was observed in 10 of the 16 patients suffering from lumbar instability. However, the disc was normal in 13 and abnormal in seven of 20 unstable segments. In the latter group the disc was markedly degenerated in 6 cases. MR examination indicated disc degeneration also in six stable spinal segments. These abnormal discs were radiographically associated with normal findings in 1 case, Scheuermann's disease in 2 cases, narrowed disc space in 2 cases, and spondylolisthesis in 1 case. Twenty-two of the 34 asymptomatic volunteers had a normal MR image while 12 subjects displayed abnormal discs at one or more levels representing incipient disc degeneration.

Figure 1 demonstrates the patient who had a normal lumbosacral radiograph, an unstable segment at the L5–S1 level, and one abnormal disc on the MR scan.

Discussion

The main conclusion of our study is that lumbar instability is uncommon in young patients with low back pain. Only 16 of 75 had unstable segments in flexion-extension radiographs. Further, the disc was seldom degenerated in the unstable segments. Earlier studies have suggested that abnormal mobility of the lumbar segments is associated with disc degeneration (Knutson 1944, Morgan and King 1957, Stokes et al. 1981, Farfan and Gracovetsky 1984, Seligman et al. 1984).

The reason for instability in occasional cases may be abnormality of the apophyseal joints or laxity of the ligaments adjacent to the disc. Cadaver studies indicate that intervertebral discs may be well preserved in nontraumatic instability and that degeneration of apophyseal joints is more advanced than that of corresponding discs (Farfan 1980). We do not know whether or not the facet joints were damaged in our series. Plain radiography has almost no diagnostic value in the assessment of the apophyseal joints (Reichmann 1973).

We used 3 mm or more as a criterion for abnormal translational movement. This is in close agreement with Dupuis et al. (1985), although they suggested that a shear greater than 4 mm in the L5–S1 segment is pathologic. The translational motion (mean 3.5 mm) observed in our study was less than that reported by others (Morgan and King 1957). This may be explained by the young age of our patients. In older patients nonspecific disc degeneration is seen frequently; it is mostly not related to segmental instability. Therefore, the relationship between segmental instability and disc degeneration in the elderly is impossible to assess. Powell et al. (1986) examined 302 asymptomatic women using MR imaging, and found that almost 10 percent of those under aged 20 years had disc degeneration, the corresponding percentage for those aged 21–30 years being over 30 percent. Similarly, Gibson et al. (1987) found asymptomatic disc degeneration in 20 percent of control subjects aged 19 years. The pathologic MRI observed in one third of asymptomatic controls in our study may represent early age changes.

We are aware of the inability of simple flexion-extension radiographs to demonstrate the complex motion of the lumbar spine. More sophisticated methods, such as three-dimensional radiographic analysis (Stokes et al. 1981, Pearcy et al. 1984, Seligman et al. 1984) or specific positions (Keessen et al. 1984), are more accurate to record abnormal motion patterns. Our study confirms the findings of Knutsson (1944), showing that abnormal translational motion occurs in the lumbar spine without signs of disc degeneration.

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