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Disc Degeneration in Low Back Pain

A 17-Year Follow-up Study Using Magnetic Resonance Imaging

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Study Design. A prospective, cohort clinical and magnetic resonance imaging (MRI) study of patients with low back pain.

Objective. To study if lumbar disc degeneration (DD), diagnosed in young patients with low back pain by using MRI will predict chronic pain, disc herniation, or functional disability after a 17-year follow-up.

Summary of Background Data. In 1987, 75 male Finnish conscripts aged 20 years, with low back pain hindering their military service, were studied using MRI at 0.02 T.

Methods. In 2003, 32 patients were reexamined with MRI at 1.0 T. The history of low back illness during the follow-up and current functional outcome were recorded.

Results. In 1987, 69% of the 32-patient cohort had DD in one or more lumbar discs. In 2003, all subjects had DD in MRI. The mean number of degenerated discs in each subject increased from 1.1 to 3.0. A total of 76% of discs degenerated in 1987 were herniated in 2003, whereas only 29% of well-hydrated discs in 1987 were herniated at the time of follow-up ($P = 0.0002$). During 17 years of follow-up, 3 patients had undergone spinal surgery.

Conclusions. Early DD in adolescent patients with low back pain predicted the evolution of enhanced DD and herniation in adulthood, but it was not associated with severe low back pain or increased frequency of spinal surgery.

Key words: disc degeneration, disc prolapse, herniation, magnetic resonance imaging, low back pain. **Spine 2007;32:681–684**

Low back pain (LBP) of young individuals is relatively common in the western society.[1–4] Degeneration of intervertebral discs is a progressive and normal age-related phenomenon in adults. If exacerbated, it may cause LBP and disc herniation,[5,6] but the causal association has not been firmly established.[7,8] Disc degeneration (DD) is reported to be more common in patients with LBP than in asymptomatic subjects.[5,9,10] Various occupational backgrounds and genetic predispositions have been shown to affect the occurrence of DD.[5,10] However, the causal association of early DD in adolescence and spinal disorders in the long-term follow-up is unknown.

Magnetic resonance imaging (MRI) provides a powerful tool for assessing the degree of DD and herniation.[11] We used MRI early in 1987 to find out the frequency of DD in a group of 20-year-old LBP patients.[9] One or more lumbar discs were seen to be degenerated in MRI in 57% of the patients with chronic LBP compared with 35% of the asymptomatic controls. In 2003, all patients were contacted in order to perform a clinical examination and MRI. The purpose was to evaluate whether DD diagnosed in adolescence would predict progression of structural changes in the discs and low back disability in adulthood. In particular, we were interested in seeing if premature DD would progress to disc herniation or increase the frequency of disc surgery.

Materials and Methods

Patients. A total of 75 male LBP patients, aged 20 years, were studied in 1987 for the presence of lumbar DD by using T2-weighted MRI.[9] The patients were Finnish male conscripts referred to the Central Military Hospital of the Finnish Defense Forces for LBP. All of them had a history of LBP of over 2 to 3 months severe enough to hinder their participation in military service. In 2003, a questionnaire was submitted to the subjects, out of which 32 patients were contacted and reexamined by MRI. Six of the 75 individuals could not be reached (3 had died, 2 had no constant address, 1 lives abroad). Thirty-one individuals did not respond to the written questionnaire (twice submitted). Presence of chronic LPB and the current functional outcome were recorded. Mean age of the subjects at the time of the repeated MRI was 37 (SD 0.9) years.

Magnetic Resonance Imaging. In 1987, MRI was performed with a 0.02 T low-strength field scanner (Acutscan, Instrumentarium Corp.).[9] The technical details have been described earlier.[9] In 2003, MRI was performed with a 1.0 T scanner (GE Signa, Milwaukee, WI) using a surface coil. Routine sagittal T2-weighted (TR 4000, TE 96.9), sagittal T1-weighted (TR 600, TE 10.0), and axial T2-weighted (TR 3000, TE 123:5) spin-echo sequence (flip angle 90°) images were obtained. The appearance of DD in MRI was based on the intensity calculations of each disc by using region-of interest facility in sagittal T2-weighted images as previously reported.[9] The intervertebral disc with the highest signal intensity on T2-weighted MR images was considered healthy and well-hydrated. All other discs with a signal intensity less than 80% of the healthiest reference disc were considered to be degenerated. Disc herniation and other significant disc abnormalities were assessed in T2-weighted sagittal and T1-weighted axial images by 2 radiologists independently in a blinded fashion (M.E., H.H.). Herniation of a disc at each intervertebral level

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was classified as negative or positive. Negative indicates a normal disc or a minimal bulge, and positive indicates a diffuse bulge or herniation.

Clinical Examination. The clinical examination and history of LBP of each patient during the follow-up were recorded. A standard clinical examination included straight leg raising test, evaluation of sensory, motor and jerk functions, an assessment of lumbar scoliosis, and spinal mobility (Schober's test) according to the previous study. A visual analog scale and the Low-Back Outcome Score (LBOS)[12] were used to assess the patient's current pain levels and subjective disability, respectively. The LBOS consists of 13 questions, each dealing with either pain or an area of daily activity likely to be affected by back pain. This is a well-validated measure and has been used in a number of LBP studies.[12,13]

Statistical Analysis. The frequency of physical and MRI findings between the patients with normal and degenerated discs were compared by using Fisher exact test.

■ Results

Of the 32 subjects (84%) participating in this follow-up study, 27 reported recurrent LBP and 19 of these (70%) had DD in the MR scans in 1987. Of these all, 21 reported LBP referring in lower extremities (Table 1). None of the patients was retired. During the 17 years, only 2 patients with early DD and 1 patient with normal discs had undergone spinal surgery. The present LBOS was 57 (SD 13) for the subjects with DD in 1987 scans and 58 (SD 17) for the subjects with no DD in 1987. The mean visual analog scale for LBP was 3.1 (SD 2.6) and 3.6 (SD 2.3), respectively. There were some minor differences in clinical findings within the patients with early DD compared with the patients with normal discs in MRI, but they were not statistically significant (Table 1).

A significant progression of DD was found during the follow-up period. In 1987, one or more lumbar discs were degenerated in 22 of 32 (69%) subjects. In the original material of 75 patients, the corresponding value was 43 of 75 (57%).[9] In 2003, DD was seen in all 32 patients (100%). Considering all lumbar discs in 1987, 34 of 160 (21%) of them were degenerated (Table 2). Of these, 32 of 34 were also degenerated in 2003. In addition to this, 64 (51%) of the normal discs in 1987 were found to be degenerated in 2003 (Table 2). All in all, 60% of lumbar discs in the 37-year-old subjects were degenerated in 2003 (Table 2).

Table 1. Physical Signs and Symptoms of LBP Patients in 2003 and the Presence of the Disc Degeneration in 1987

		MRI finding in 1987		
Physical Sign in 2003	n	Normal MRI (n = 10)	DD in MRI (n = 22)	Statistical Significance
Positive leg raising test	2	1	1	0.530
Tight hamstring	7	4	3	0.165
Weak or absent ankle jerk	13	6	7	0.244
Weak or absent knee jerk	14	7	7	0.062
Sensory changes	10	2	8	0.439
Motor weakness	0	0	0	—
Lumbar scoliosis	14	3	11	0.446
Limited lumbar mobility	10	2	8	0.683
Referred pain in lower extremities	21	5	16	0.450

*All patients had disc degeneration in one or more levels in 2003.

Table 2. The Disc Abnormalities in 1987 and 2003

	Disc Degeneration	MRI Findings in 2003 [no. (%)]		
Level	in 1987 [no. (%)]	Normal	Degeneration	Herniation
L1–L2	3/32 (9)	19/32 (59)	12/32 (38)	1/32 (3)
L2–L3	3/32 (9)	20/32 (63)	10/32 (31)	3/32 (9)
L3–L4	2/32 (6)	10/32 (31)	20/32 (63)	11/32 (34)
L4–L5	12/32 (38)	2/32 (6)	28/32 (88)	25/32 (78)
L5–S1	14/32 (44)	5/32 (16)	26/32 (81)	23/32 (72)
Total	34/160 (21)	56/160 (35)	96/160 (60)	63/160 (39)

The numbers refer to the number of discs.

An anatomic distribution of lumbar DD is presented in Figure 1. The total number of degenerated discs was increased significantly in 2003 compared with the original scans in 1987 (96 *vs.* 34, $P < 0.0001$). The mean amount of degenerated discs per individual increased from 1.1 to 3.0 during the study period. In 1987, the degeneration was located mainly in 1 of the 2 lowermost disc spaces, whereas currently the abnormal discs were seen in all disc spaces (Table 2; Figure 1). However, the 2 uppermost disc spaces were still proportionally less affected.

The DD in MRI scans was related to an increased risk of disc prolapse. Based on the early degeneration found in the original MR scans in 1987, the percent values of disc herniation in 2003 were 76% and 29% in the degenerated and well-hydrated discs, respectively ($P = 0.0002$). Considering only the 2003 MR scans, 59% of the degenerated discs were herniated, whereas 9% well-hydrated discs were herniated. The difference was statistically significant ($P = 0.0001$).

■ Discussion

Disc degeneration is part of the normal aging process of the intervertebral disc and a frequent finding among young adults. In our previous study, 2 of 3 20-year-old LBP patients had one or more degenerated lumbar discs in MRI.[9] After a 17-year follow-up, DD was present in all of the patients. The total number of degenerated lumbar discs increased from 21% to 60% in the LBP group. The lack of a control group in the present study is a disadvantage. We were not able to reach our original control group to compare the MRI findings to the normal population. Our earlier MRI study of the same age group indicated, however, that about 30% of lumbar discs have reduced signal intensity in asymptomatic Finnish subjects at the ages between 30 and 39 years.[14]

Is DD at the beginning a painful process? Many discographic studies report that tears of anulus fibrosus are

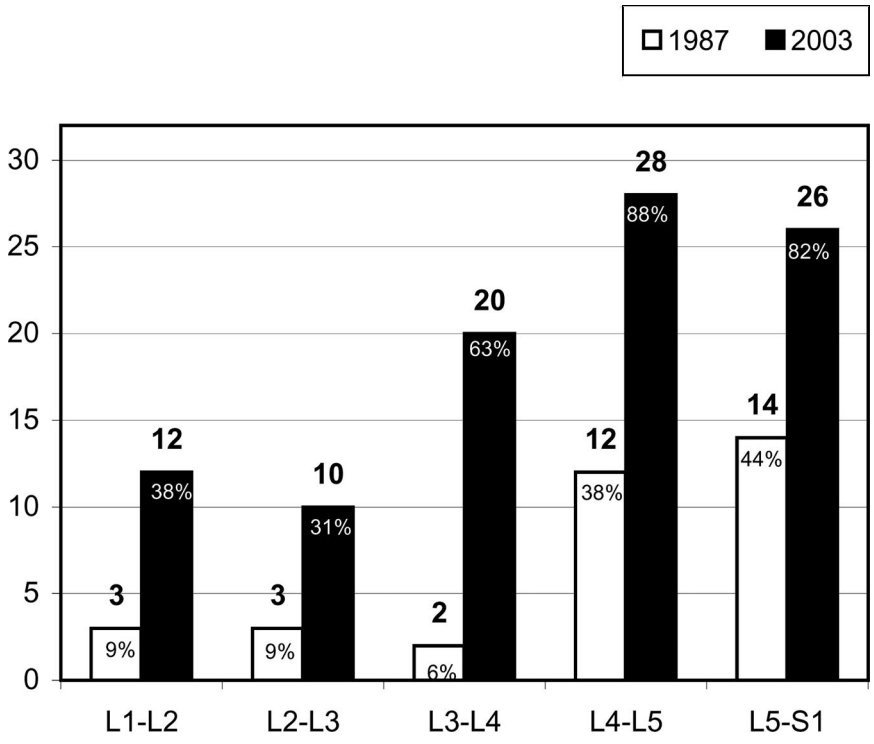

Figure 1. Distribution of degenerated discs of 32 subjects during 1987 and 2003. The numbers refer to the number of discs.

sometimes painful.[4] In MRI studies, the causal role of lumbar DD in the LBP syndrome is somewhat more controversial than in discography.[3,10,14,15,16] Our present study shows that DD found in adolescence had an increased risk for disc herniation in mature adults. Most herniated discs caused only minor symptoms, and a tendency to spontaneous healing was common. Over 80% of the subjects in our follow-up group did have recurrent LBP. The LBOS was similar in both the DD and non-DD groups, and the normal physical activity was only slightly restricted in our subjects with or without pain.[12,13] Lumbar pain in our 32-patient group was usually mild and recurrent, of which 3 patients had reported having had disc surgery. Recent cross-sectional and follow-up studies have reported a moderate association between DD and LBP.[1,2,10] On the other hand, the findings on MRI scans were not predictive on the development or duration of LBP.[15,16] In a 7-year follow-up study by Borenstein *et al*,[16] individuals with the longest duration of LBP did not have the greatest degree of anatomic abnormality in the original MRI scans. Even in youngsters, significant MRI changes in the discs related to LBP have been identified.[1,4]

There is no standard definition of DD in MRI. Signal intensity of nucleus pulposus in T2-weighted imaging is probably the most sensitive sign for DD.[11] The measurement of signal intensity should be adjusted by the signal intensity of standard samples along the imaged spine. In our study, the reference value for each degenerated disc was the signal intensity of the healthiest disc in the same subject. This is the most commonly proposed method to analyze DD in MRI.[11,15] The technology of MRI scanners has greatly developed during the last decades. In 1987, we used a 0.02 T ultra-low-strength field MRI scanner, which is reliable in measuring the signal intensities of lumbar intervertebral discs despite the limited spatial resolution.[9] New and potentially useful imaging strategies for spine imaging include dynamic magnetic resonance imaging, functional MRI, diffusion imaging, and MR spectroscopy.[11] It is presently unknown whether these new methods will give more advanced information of painful discs than discography.

We have previously shown in large cross-sectional MRI studies that lumbar DD manifests earlier and in a greater percentage of subjects with LBP than asymptomatic controls. Our present study shows that adolescent patients with LBP experienced further DD over a 17-year period of follow-up. Degenerated discs identified in 1987 showed evidence of herniation at follow-up in 2003. However, there was no increase in episodes of severe LBP or apparent incidence of spinal surgery.

■ Key Points

- In 1987, two thirds of the cohort of 32 LBP patients 20 years of age had disc degeneration in one or more lumbar discs.
- After a 17-year follow-up, disc degeneration was present in all patients, the mean number of degenerated discs per subject having increased from 1.1 to 3.0.
- Disc degeneration diagnosed in MRI in adolescence was related to asymptomatic disc herniation in later adulthood.

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