

The prevalence of lumbar facet joint edema in patients with low back pain

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Abstract

Objective The objective was to assess the prevalence of lumbar facet joint edema in patients with low back pain.

Materials and methods Lumbar spine MR examinations (1.5 T) of 145 consecutive patients (87 women, 58 men; mean age 52.8, range 17–94 years) were retrospectively evaluated with regard to the presence of facet joint edema. The MR protocol included sagittal short-tau inversion recovery (STIR), T1- and T2-weighted as well as transverse T2-weighted images. In 9 patients follow-up MR examinations were performed and results were compared with pain. The agreement between the change in intensity of facet joint edema and the change in intensity of pain was assessed using kappa statistics and Kendall's tau coefficient.

Results In 21 of the 145 patients (14%) edema was found at the facet joints: in 52.4% at L4/5, in 19.0% at L5/S1, in 14.3% at L4/5 and L5/S1, in 9.5% at L3/4 and L4/5, and in 4.8% at L3/4. The agreement between the change in pain score and intensity of edema within the follow-up group was "almost perfect" (kappa=0.81). Kendall's tau coefficient was 0.91, indicating high agreement.

Conclusion Sagittal STIR images detect facet joint edema in 14% of patients with low back pain. This fact may be useful for planning treatment including facet joint injections.

Keywords Zygapophysial joint · Edema · Spine · Low back pain · Magnetic resonance imaging

Introduction

Low back pain, which is defined as pain occurring between the costal margins and the gluteal folds, has a lifetime prevalence of about 60–70% [1]. Back pain is the most common cause of chronic illness in men and women less than 64 years of age and the second most common between the ages of 65 and 74. In general, there is a slight increase in back pain in the population with increasing age [2]. The incidence of back pain is high and the socioeconomic implications of associated disability and financial costs are growing rapidly. The total cost of back pain represents 1 to 2% of the gross national product in the OECD (Organization for Economic Co-operation and Development) countries [3].

Magnetic resonance imaging is important for the determination of the source of pain and to guide treatment. Unfortunately, the relationship between many MR findings and the patients' symptoms is often poor [4]. Disc abnormalities, including degeneration, bulging, protrusion and annular tears occur in a substantial percentage of asymptomatic volunteers [5, 6]. In contrast, bone marrow abnormalities related to the endplate as described by Modic et al. [7] are uncommon in asymptomatic volunteers [8]. Similar changes can be found at the facet joints. We believe that facet joint abnormalities have been under reported in the literature. This study concentrates on bone marrow abnormalities with the signal behavior of Modic I changes and soft tissue edema surrounding the facet joints, which we refer to as "facet joint edema." The aim of this study was to evaluate the prevalence of facet joint edema in the lumbar spine of patients with lower back pain.

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Materials and methods

Magnetic resonance examinations of the lumbar spine obtained in 247 consecutive patients referred to our Institution for investigation of lower back pain were available for retrospective review. The MR examinations were performed between March 2004 and June 2005 on a 1.5-T MR scanner (Magnetom Vision; Siemens, Erlangen, Germany). After excluding patients with congenital disorders, metastases, infections, fractures, surgery, lumbar injections, and those under the age of 17 years, 145 patients (87 women and 58 men; mean age 52.8, range 17–94 years) were included in the study. Institutional review board approval was obtained.

A standardized MR protocol using a spine array coil was applied:

1. Sagittal STIR (short-tau inversion recovery; 5,100/29 [repetition time ms/echo time ms], 150 [inversion time ms], 256×256 [image matrix], 280 [field of view mm], 4 [section thickness mm], 0.4 [intersection gap mm], 180 [flip angle °]),
2. Sagittal T1-weighted SE (665/14, 512×512, 320, 3, 0.6, 90),
3. Sagittal T2-weighted FSE (4,600/112, 512×512, 280, 4, 0.8, 180),
4. Axial T2-weighted FSE (7,000/112, 256×256, 220, 3, 0.6, 180).

Two experienced musculoskeletal radiologists (ST 15 years, KF 4 years) reviewed the 145 MR examinations and by consensus identified those patients with edema of any of the lumbar facet joints. The intensity of bone marrow edema and surrounding soft tissue edema of the facet joints was graded on STIR images as follows: none (0); mild (1), minimal hyperintensity; moderate (2), unequivocal hyperintensity; severe (3), extensive hyperintensity. The side and levels of the abnormalities were noted, as well as the presence and grading of facet joint osteoarthritis; the presence and grading of disc degeneration; the presence and grading of disc herniation; the presence, side, and grading of scoliosis; the presence of spondylolisthesis and grading of anterolisthesis. Osteoarthritis of the facet joints was graded using criteria adapted from Pathria et al.

(Table 1) [9]. Disc degeneration was classified as one of the following four grades [10]: normal; mild, slight dehydration of the disc on T2-weighted images; moderate, disc dehydration and mild loss of disc height; and severe, total disc dehydration with nearly complete loss of disc height. Disc herniation was classified according to the North American Spine Society guidelines [11]. Scoliosis was evaluated on standard radiographs that had been routinely obtained in our institution before MRI of the lumbar spine. For scoliosis a classification into four grades was chosen: none (0); mild (1), Cobb angle <25°; moderate (2), Cobb angle 25–50°; and severe (3), Cobb angle >50°. A Fisher–Freeman–Halton test and a contingency coefficient (CC) were used to determine the relationship between the side of edema and the side of scoliosis. Anterolisthesis was graded according to Meyerding [12].

All patients with facet joint abnormalities were invited by telephone for a follow-up MR examination at our institution. Twelve patients did not enter into the follow-up study because surgery had been performed ($n=3$), because they declined to participate ($n=4$) or because they were lost to follow-up ($n=5$).

Nine patients agreed. Follow-up examinations were performed between 6 and 12 months after the initial scans. Each patient provided written informed consent for both MRI and the retrospective data analysis. The follow-up examination was performed according to the same standardized MRI protocol. Each patient completed a questionnaire including a visual analogue scale [13] in order to assess pain intensity. Back and leg pain during the previous week and on the examination day were measured on a scale between “0” (pain is not bothersome at all) and “100” (pain is extremely bothersome) [13]. These data were analyzed by a reader not involved in the evaluation of the MR images (SN). The change in pain intensity from the basic to the follow-up examination was calculated by subtraction of the given values of the scales, and was graded as “increasing,” “decreasing,” or “stable.” The two readers (ST and KF) who evaluated the follow-up MR images were blind to the patients’ clinical data. The change in intensity of facet joint edema was graded as “increasing,” “decreasing,” or “stable.”

In order to assess the agreement between the change in intensity of facet joint edema and the change in the

Table 1 Criteria for grading osteoarthritis of the facet joints adapted from Pathria et al. [9]

Grade	Criteria
0	Normal facet joint space (2–4 mm width)
1	Narrowing of the facet joint space (<2 mm) and/or small osteophytes and/or mild hypertrophy of the articular process
2	Narrowing of the facet joint space and/or moderate osteophytes and/or moderate hypertrophy of the articular process and/or mild subarticular bone erosions
3	Narrowing of the facet joint space and/or large osteophytes and/or severe hypertrophy of the articular process and/or severe subarticular bone erosions and/or subchondral cysts

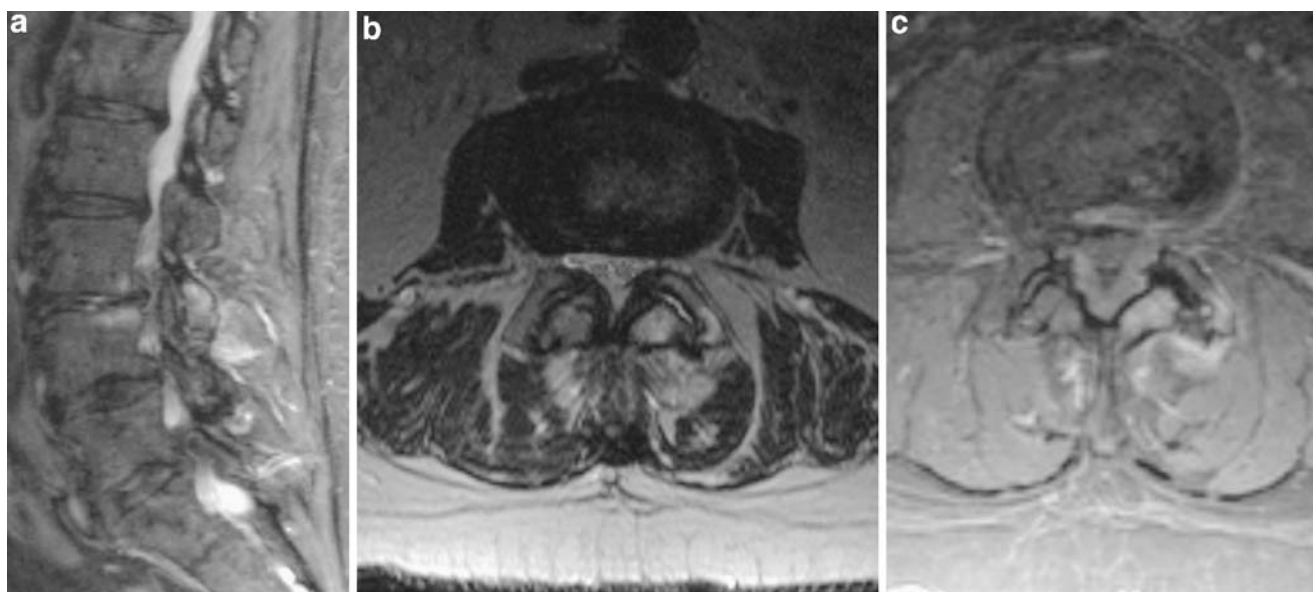


Fig. 1 A 76-year-old woman with lower back pain, bone marrow edema, surrounding soft tissue edema, and joint effusion at the left facet joint L3/4. **a** STIR (short-tau inversion recovery) sagittal image,

b T2-weighted axial image, and **c** T1-weighted axial image with fat saturation after application of contrast agent

intensity of pain, a kappa statistic was used. Kendall's tau coefficient was calculated.

Results

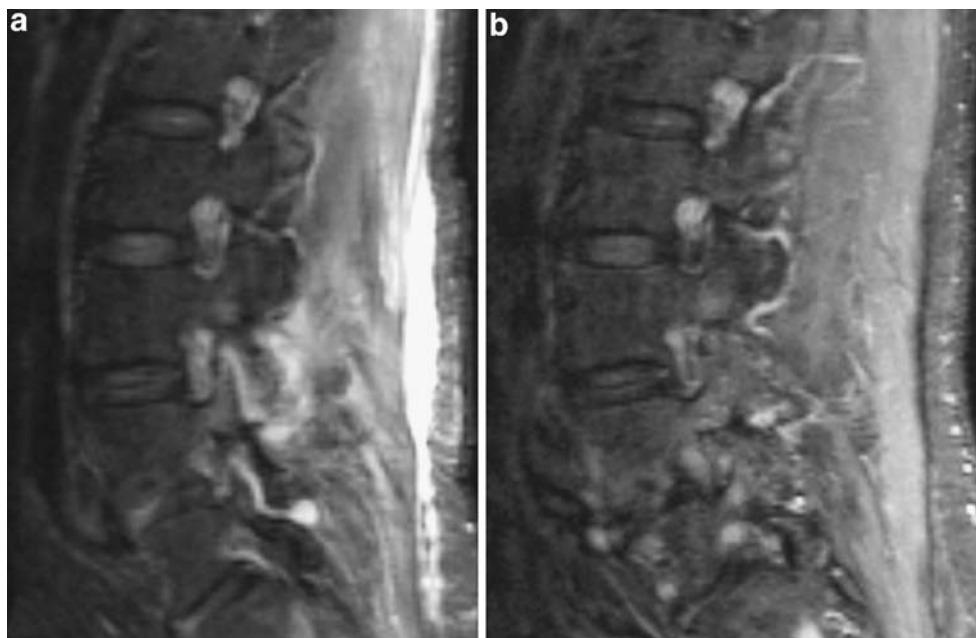
In 21 of the 145 patients (14%) bone marrow and surrounding soft tissue edema at the lumbar facet joints (Fig. 1) was diagnosed. The mean age of those 21 patients was 61.9 years (range 42–94), 13 of them were female (mean age 60.5 years, range 42–76), and 8 male (mean age 64.0 years, range 45–94). Facet joint edema was on the right in 6, on the left in 5, and bilateral in 10 patients. Abnormalities were found at L4/5 ($n=11$), at L5/S1 ($n=4$), at L4/5 and L5/S1 ($n=3$), at L3/4 and L4/5 ($n=2$), and at L3/4 ($n=1$).

The following findings were found in conjunction with facet joint edema (Table 2). Osteoarthritis of the facet joints was seen in all of the facet joints with edema (mild [$n=4$], moderate [$n=12$], and severe [$n=5$]). Disc degeneration was found at the level of facet joint edema in 20 of the 21 patients (mild [$n=9$], moderate [$n=10$], severe [$n=1$]). Grade 1 disc herniation was found in 10, grade 2 in 8, and grade 3 in 1 patient. Eleven patients had mild lumbar scoliosis. In 5 of the 7 patients with scoliosis unilateral facet joint edema was found on the concave side of scoliosis (Fisher–Freeman–Halton test: $p=0.071$; $CC=0.63$). Twelve patients had anterolisthesis at the segment with facet joint edema. No retrolisthesis was found in any of the patients with facet joint edema.

Table 2 Additional findings in patients with facet joint edema

Findings	Grading	Number of patients
Facet joint osteoarthritis	Σ	21
	Grade 0	0
	Grade 1	4
	Grade 2	12
	Grade 3	5
Disc degeneration	Σ	20
	Grade 0	1
	Grade 1	9
	Grade 2	10
	Grade 3	1
Disc herniation	Σ	19
	Grade 0	2
	Grade 1	10
	Grade 2	8
	Grade 3	1
Scoliosis	Σ	11
	Grade 0	10
	Grade 1	11
	Grade 2	0
	Grade 3	0
Anterolisthesis	Σ	12
	Grade 0	9
	Grade 1	12
	Grade 2	0
	Grade 3	0
	Grade 4	0

Fig. 2 A 69-year-old man reporting more pain at **a** the basic examination than at **b** the follow-up examination. **a, b** Sagittal STIR images. A regression of the soft tissue and bone marrow edema of the facet joint L3/4 is visible (**b**)



In the 9 patients with follow-up examinations (Figs. 2, 3) no changes in the severity of facet joint osteoarthritis, disc abnormalities, scoliosis, or anterolisthesis were found. Facet joint edema increased in 2 patients (both of whom had increasing pain), remained stable in 3 patients (unchanged pain in 2), and decreased in 4 patients (decreased pain in all 4 patients; Table 3).

Using the kappa statistic a significant agreement between the ratings with regard to the change in intensity of facet joint edema and the change in pain intensity (Figs. 2, 3) was

found (kappa=0.81; 95% confidence interval 0.47–1.16; $p < 0.05$). The agreement was “almost perfect” [14]. Kendall’s tau coefficient also indicated high agreement (0.91).

Discussion

So-called bone marrow edema is a common cause of pain of the musculoskeletal system [15]. Bone marrow hyperintensity

Fig. 3 A 76-year-old woman reporting more pain at **a** the basic examination than at **b** the follow-up examination. **a, b** Sagittal STIR images. A regression of the soft tissue edema and bone marrow edema of the facet joint L5/S1 is visible (**b**)

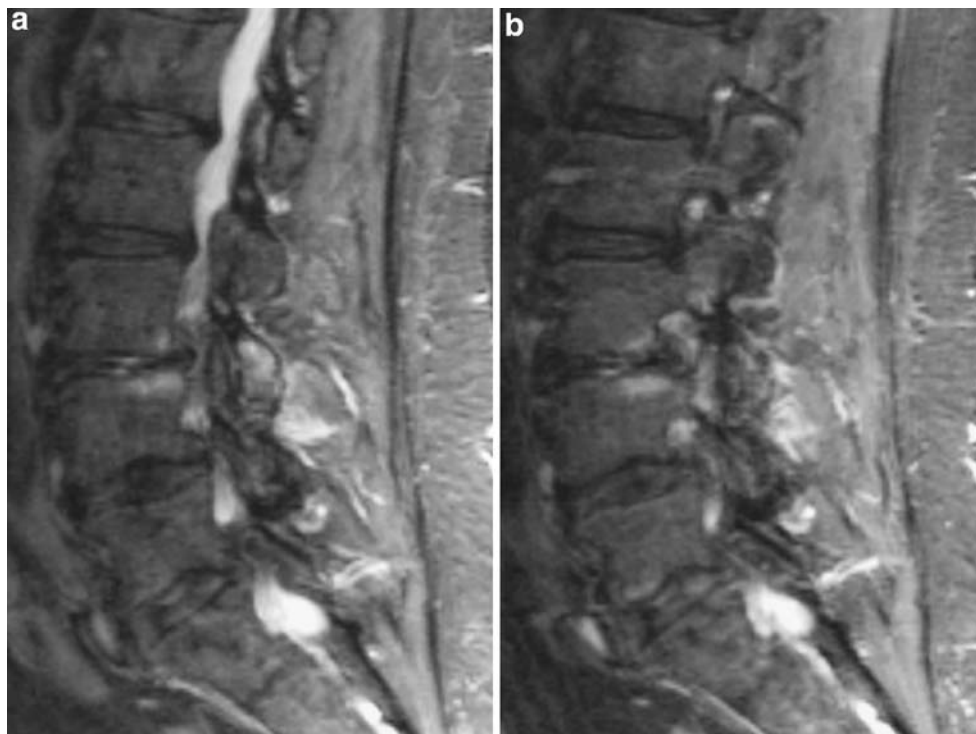


Table 3 Change in pain intensities and intensities of facet joint edema

Patients	Visual Analogue Scale score (basic/follow-up)	Change in pain intensity	Intensity of facet joint edema (basic/follow-up)	Change in intensity of facet joint edema
P1	35/70	Increasing	1/1	Stable
P2	50/30	Decreasing	2/1	Decreasing
P3	50/50	Stable	3/3	Stable
P4	95/30	Decreasing	3/2	Decreasing
P5	75/45	Decreasing	3/2	Decreasing
P6	50/70	Increasing	2/3	Increasing
P7	60/60	Stable	1/1	Stable
P8	50/70	Increasing	½	Increasing
P9	70/0	Decreasing	3/2	Decreasing

seen on T2-weighted spin-echo and STIR images may not only be caused by edema, but also by necrosis, fibrosis, and trabecular abnormalities [16]. STIR and sequences using frequency-selective fat suppression improve lesion conspicuity in suspected bone marrow abnormalities [17]. Gadolinium-containing intravenous contrast agents may improve visualization of soft tissue and bone marrow abnormalities (Fig. 1c). In this retrospective study contrast agent had been applied in only 2 of the patients who had had massive abnormalities on the STIR sequence because infection or a neoplasm had to be excluded. Based on our own experience and the literature [18] we believe that contrast enhancement is not required in a routine protocol.

In our study population facet joint edema was found in a considerable percentage of patients with low back pain. The pathogenesis of facet joint edema is unclear. Similar to peripheral joints, overload and degenerative changes may be associated with signal abnormalities [19]. Joint overload may occur in malalignment, neuromuscular dysfunction, ligament loosening, and repetitive trauma. In this study facet joint edema was most commonly found at the L4/5 and L5/S1 levels. This is similar to the distribution of disc herniations: 95% of lumbar disc herniations occur at the same two levels [20], consistent with the fact that facet joints and intervertebral discs form a functional unit [21]. Disc degeneration usually precedes osteoarthritis of the facet joints [22]. Forty-five percent of the disc degenerations were graded as mild, 50% moderate, and only 5% severe (Table 2). This distribution is consistent with the theory of Kirkaldy-Willis, who proposed three phases of lumbar spine degeneration [23]. In the second phase the intervertebral disc has a reduced height and loses its mechanical properties. Ligaments and joint capsules become loose and degenerative changes occur in the facet joints. These changes result in an increased and abnormal range of motion. Instability is associated with repetitive stress and overload for the facet joints, which may lead to bone marrow edema. This theory is also supported by the

fact that in 12 of the 21 patients with facet joint edema we found anterolisthesis in the same segment (Table 2). Scoliosis may also place stress on the facet joints, and this is supported by our data. We believe that edema is predominantly visible on the concave side of scoliosis, because of higher stress on that side. An asymmetric orientation of the lumbar facet joints is believed to be another factor that causes overload in the facet joints of the lumbar spine [24]. Overload leads to damage of the cartilage and the subchondral region as well as synovitis, which may cause joint effusion and soft tissue edema around the facet joints (Fig. 1). Microscopic hemorrhage and microfractures, hyperemia, cellular infiltration, and proliferation of fibrovascular tissue may contribute to MRI signal abnormalities. Finally, subchondral cysts and sclerosis may develop. Facet joint edema may also be found in patients with ankylosing spondylitis [25]. This entity is far less common and can be differentiated from degenerative changes based on history, clinical findings, and disease-specific distribution. Ankylosing spondylitis should be kept in mind as a differential diagnosis especially in young patients with inflammatory low back pain, additional radiological signs of sacroiliitis and a HLA-B27-positive blood test.

A limitation of our study is that it is a retrospective analysis. This has the disadvantage that the symptoms of the patients who did not enrol for the follow-up examination could only be evaluated by their medical records. In addition, we were not able to compare our results with a healthy population. In addition, it is difficult to prove that the patients' pain originated solely from the facet joints and not from other abnormalities including disc disease. This problem is in part solved by the follow-up examinations, which demonstrated a relationship between facet joint findings and pain.

In conclusion, sagittal STIR images detect facet joint edema in 14% of patients with low back pain. This fact may be useful for planning treatment including facet joint injections.

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