Synovial Cysts of the Lumbar Facet Joints: A Retrospective Magnetic Resonance Imaging Study Investigating their Relation with Degenerative Spondylolisthesis

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Abstract: Patients with synovial cysts of the facet joints were compared with patients with degenerative spondylolisthesis (DS), based on the magnetic resonance imaging (MRI) findings of their spondyloses. The lumbar MRI of 30 patients with DS (group 1) 24 patients with synovial cysts of the facet joints (group 2) were studied. All patients were evaluated in terms of facet joint arthritis, disc degeneration, facet joint effusion, and the thickness of the flaval ligament. 54.1% of the patients with synovial cysts had associated DS. The mean grade of disc degeneration (2.43±0.50 and 2.13±0.68 in groups 1 and 2, respectively) and the mean thickness of the flaval ligament (3.20±1.22 mm and 3.83±1.46 mm in groups 1 and 2, respectively) did not differ between the groups (p=0.093 and p=0.097). The mean grade of facet joint osteoarthritis (2.53±0.51 and 2.08±0.72 in groups 1 and 2, respectively) was significantly higher in group 1 (p=0.18). The co-existance of synovial effusion was significantly higher in cases with synovial cysts. (p=0.008). Synovial cysts are associated with DS and facet joint osteoarthritis. The presence of synovial effusion and the high degree of disc degeneration are prominent features in patients with synovial cysts. Although osteoarthritis and DS are highly concomitant with facet joint synovial cysts, both conditions do not invariably lead to a cyst formation.

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Introduction

Synovial cysts are "hypertrophic synovitis arising from the lumbar facet joints" [1–3]. Although synovial cysts of the spine may occur anywhere in the spine, they occur predominantly at the L4–5 level, which is known to be the most mobile segment. [1, 4–7]. These cysts are invariably found with degenerative arthritis of the facet joints and frequently associated with degenerative spondylolisthesis (DS). Both conditions are common in aged populations, and synovial cysts are an infrequent and probably underestimated cause of back pain and radiculopathy. With the advent of magnetic resonance imaging (MRI), the diagnostic rate of spinal synovial cysts has increased rapidly although the incidence is still low (0.6–2%) [1, 5, 6, 8–13].

Degenerative spondylolisthesis occurs due to a forward motion (slip) of one vertebral body over the one below in the sagittal plane, and is most predominant at the L4–5 level, as synovial cysts. DS is caused by the degeneration of the restraining structures of the spinal motion segment: the intervertebral disc, intervening muscles and ligaments, capsules, and facet joints. MRI enables visualization of all findings linked with DS, such as facet joint orientation, facet joint osteoarthritis, and presence of synovial cysts [3, 4, 7, 8, 10]. Recent studies revealed the association of facet joint's synovial cysts with facet joint effusion [1, 12], facet osteoarthritis [4, 5, 9], and intervertebral instability [4]. This present study is different from previous studies in that the cases with lumbar facet synovial cysts are compared with the DS cases in terms of facet joint osteoarthritis, facet joint effusion, disc degeneration, and thickness of the flaval ligament.

Material and Methods

In this cross-sectional study patients who were referred to our university hospital's radiology department for lumbar magnetic resonance imaging (MRI) examination were evaluated. All patients had low back pain or radicular leg pain. MR images of the patients were obtained in the sagittal and transverse planes with the use of body coils on a Magnetom 1.0-T unit (Siemens, Impact, Germany). A 256×256 matrix, 28 cm field of view, four excitations, and 4 mm section thickness with 1 mm intersection gap were used. No contrast medium was used. Fast T1-W (450–600/10–12; TR/TE) and T2-W (3500–7500/100–130; TR/TE), fat saturated T2-W (3500/90; TR/TE) sagittal, and transverse T2-W (4500–6000/125–130) fast spin echo images were obtained from all patients. All images were then evaluated by the same radiologist experienced in interpreting the MR scans of musculoskeletal system. Thirty patients with only DS (without synovial cyst) (group 1) and 24 patients with synovial cyst of the facet joints (group 2) were idendified with respect to their MR images (Figures 1–3). The maximum size, location (anterior/posterior), signal characteristics (hemorrhagic/nonhemorrhagic), relationship to the facet joint, and presence of spondylolisthesis were recorded. Patients with vertebral tumors, traumas, spondylodiscitis, spondylolysis, lytic spondylolisthesis, and scoliosis were excluded.

All patients were graded according to facet joint osteoarthritis and disc degeneration using the same methods described in the previous studies (Table 1) [10, 13]. Patients were graded on a scale of 0 to 3, and the grade increased with the increased level of degeneration. The degree of spondylolisthesis was graded according to Meyerding's [14] classification. The presence or absence of fluid in the facet joints was recorded on T2-W fast spin echo transverse scans. When the measured thickness of the visible fluid layer within the joint was more than 1 mm, it was considered as the presence of synovial effusion. The thickness of the flaval

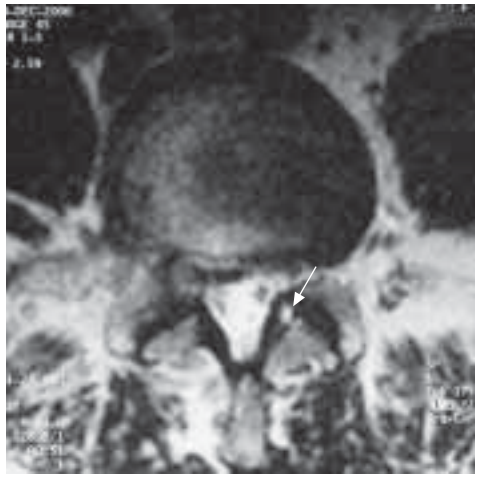

Figure 1 – Axial T2-weighted MRI. Milimetric left anterior synovial cyst, under the ligamentum flavum is seen. The cyst does not compress on thecal sac or nerve root. Note the bilateral mild osteoarthritic changes.

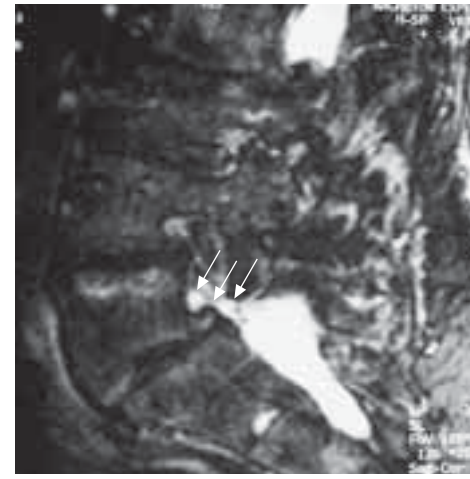

Figure 2 – T2-weighted sagittal MR scan of a case with degenerative spondylolisthesis. A synovial cyst protruding into the spinal canal. The continuity with the facet joint is seen (arrows).

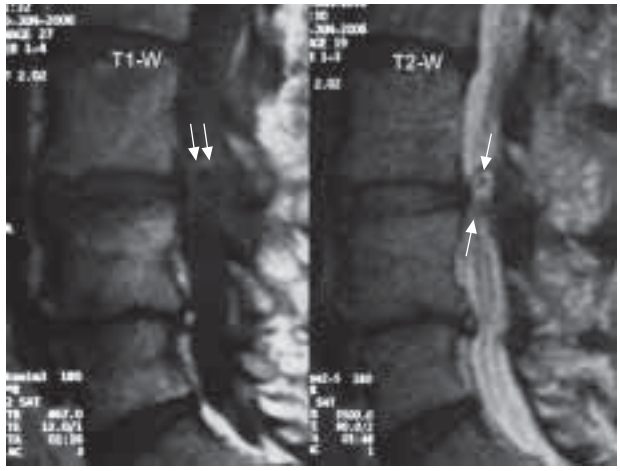

Figure 3 – T1 and T2-weighted MRI. An anterior hemorragic synovial cyst at L3-4 level.

ligaments was measured on transverse images; the distance between anterior-posterior ends of the ligament was measured from the midpoint of the ligament and recorded in millimeters.

Statistical analysis

Data are expressed as min – max (mean±SD) and median, or number (percentage). Normality distribution of the variables was tested using the one sample Kolmogorov-Smirnov test. Differences between groups were compared using Student's *t*-test for normal, Mann-Whitney *U*-test for non-normal distributed data. Categorical variables were compared by chi-square test. The effect of the prognostic markers on patients with/without facet joint synovial cysts outcome was assessed using backward stepwise logistic regression analysis. A p-value$<$0.05 was considered statistically significant. Statistica 7.0 (StatSoft Inc., Tulsa, OK, 74104 USA) statistical software was used for statistical analysis.

The facet joint effusion rate was used as the basis to calculate this study's power. The power of this study was 81.6% based on the difference in facet joint effusion rate=31.1% between groups (46.9% vs. 15.8%) with type I error (α)=5%, n1=32 and n2=38.

Table 1 – Grading system for facet joint and disc disease [10, 13]

Grade	Facet joint	Disc
0	normal	normal ± slightly heterogenous nucleus
1	slightly narrowed joint space ± small osteophytes/hypertrophy	decreased nucleus signal
2	slightly to moderately narrowed joint space ± small osteophytes/hypertrophy ± subarticular erosions	decreased nucleus signal + decreased height
3	very narrow joint space ± large osteophytes ± subarticular cysts or severe erosions ± listhesis	black disc, flattened ± prominent adjacent vertebral marrow changes

Table 2 – The comparison of patients with DS but without facet joint synovial cysts (group 1) and with synovial cyst (group 2)

	Group 1 (n=30)	Group 2 (n=24)	p
Age	47–84 (61.93±9.99) 60	47–82 (61.13±9.73) 61.5	0.944
Gender, female n(%)	26 (86.7)	18 (75.0)	0.311
Facet joint effusion, yes n(%)	4 (13.3)	12 (50.0)	0.008
Facet joint osteoarthritis	2–3 (2.53±0.51) 3	1–3 (2.08±0.72) 2	0.018
Disc degeneration	2–3 (2.43±0.50) 2	1–3 (2.13±0.68) 2	0.093
Thickness of the flaval ligament	2–6 (3.20±1.22) 3	2–6 (3.83±1.46) 3	0.097

*Data are presented as min–max (mean±SD) median, or n (%)

Results

MRI features of the DS patients (group 1)

Twenty-nine of the patients was stage 1 spondylolisthesis (slippage was <25%), and one was stage 2 (slippage was 25–50%). 12 patients (40%) had the listhesis at the L5–S1 level, 9 patients (30%) at the L4–5 level, 6 patients (20%) at the L3–4 level and 3 patients (10%) at the L2–3 level.

MRI features of the patients with facet joint synovial cysts (group 2)

Totally 32 synovial cysts were detected in 24 patients, two synovial cysts were detected in 8 patients. The diameters of synovial cysts ranged from 3 to 20 mm with a mean of 9.50±4.41 mm. Fifteen synovial cysts (46.9%) were located at the L4–5 level; eight (25%) at the L5–S1 level; seven (21.9%) at the L3–4 level; one (3.1%) at the L2–3 level and one (3.1%) at the L1–2 level.

Seventeen (53.1%) anterior lumbar facet joint synovial cysts projected into the vertebral canal, and 15 cysts (46.9%) arose from the facet joints posteriorly, external to the spinal canal.

Of 24 patients with synovial cysts, 13 (54.1%) had associated DS. Eleven synovial cysts were located at the same level with the DS; two were at the upper level from the DS.

Six (18.7%) of the cysts were hemorragic, and six (28.1%) of the cysts had visible communication with the facet joints. Seven patients had grade 3 facet joint osteoarthritis, and none of them had visible communication between synovial cysts and the facet joints.

Comparison of the groups

The comparison of the patients with facet joint synovial cysts (group 1) and the DS patients without synovial cyst (group 2) in terms of age, gender, facet joint osteoarthritis, effusion, disc degeneration and the thickness of the flaval ligament is summarized in Table 2.

Results of the multiple logistic regression models with backward stepwise method are shown in Table 3. Three variables (facet joint osteoarthritis, disc degeneration and facet joint effusion) that were found significantly in the univariate

Table 3 – Results of the logistic regression

	Patients with/without facet joint synovial cysts		
	β	p	OR (95% CI)
Facet joint osteoarthritis	–2.309	0.002	0.099 (0.022–0442)
Facet joint effusion	–2.164	0.011	8.706 (1.625–46.626)
Thickness of the flaval ligament	0.562	0.065	1.753 (0.965–3.185)

Odds ratios (OR) are calculated for facet joint synovial cysts categorized as patients of DS without synovial cyst (group 1) and patients with facet joint synovial cysts (group 2) Reference categories is "no" category is reference for facet joint effusion

analysis (Table 2) were entered to the backward logistic regression model. Facet joint osteoarthritis and facet joint effusion were found as significantly factors on outcome. The presence of facet joint effusion was the most relevant factor of the model which facet joint synovial cysts (+) rate in facet joint effusion (+) cases was odds ratio=8.706 fold higher than in facet joint effusion (–) cases. Overall percentage of the model was found 79.6%, (sensitivity=66.7%, specificity=90.0%).

Discussion

The etiology of lumbar facet joint synovial cysts is still unknown. The most frequently accepted theories of their pathogenesis are excess stress secondary to microtrauma, as well as degeneration or osteoarthritic changes causing herniation of synovial tissue through a capsular defect [5, 7, 10]. This new para-articular cavity gets filled with synovial fluid and forms the synovial cyst, which communicates initially with the joint line. In the case of the myxoid or mucoid degeneration in the synovial cyst, the cyst may lose its connection with the adjacent joint [4, 10]. The sensitivity of MRI scans to detect these cysts is 90% [6]. They are defined as round or oval collections of fluid material or blood signal arising from a facet joint and projecting beyond the visible margins of the joint. Clear demonstration of the continuity of the cyst with the facet synovium is the classic key findings for the diagnosis [3, 4]. But the rate of visualization of the connections is low (Chaput et al. reported 11%) [4]. In our study, this percentage was a little higher (28.1%). The low rate of visualization of its connection to the facet joint is explained by the smallness of these connections to be visualized. They are indeed poorly seen in MR images, computed tomography facet joint arthrogram will demonstrate better [15].

Development of synovial cysts has been linked to spondylosis, spondylolisthesis, segmental instability, and trauma [3, 5, 6, 8–11]. In accordance with the literature, we found women dominance for both synovial cysts and DS, as well as L4–5 involvement for facet joint's synovial cysts (46.9%). L4–5 is the most mobile lumbar motion segment of the vertebra and subsequently the most frequent site of both spondylosis and listhesis [3, 6]. However, as an unexpected finding, we observed that DS was mostly observed at the L5–S1 level (52.5% in L5–S1, 30.5% in L4–5). This contradiction is explained by underestimation of anterior slipping of the vertebra by MRI. In patients with mobile or low-grade listhesis, being placed in the supine position in a typical MRI scanner may cause their anterolisthesis to reduce.

As far as the association with disc abnormalities is concerned, there are conflicting results in the literature. In the retrospective study of Doyle [10], the association of synovial cysts with facet joint osteoarthritis and degenerative disc disease was examined. The study concluded that synovial cysts of the facet joints are invariably associated with degeneration of the facet joints, but it did not determine any association with disc disease. On the contrary, Tillich [7] reported

that synovial cysts are invariably associated with disc degeneration. 33–88% of patients with spondylolisthesis were reported to have associated synovial cysts in different studies [4, 12]. Our study revealed that 13 (54.1%) of the 24 patients with synovial cysts had associated DS. Our result supports that facet joints synovial cysts are invariably associated with disc degeneration and facet joint arthritis as well as DS. But osteoarthritis of the facet joints is the most determinant factor in DS. The mean osteoarthritic score was higher in the DS group (2.43±0.50 in group 1 and 2.08±0.72 in group 2, p=0.018).

The presence of facet joint effusion was significantly higher in group 2 patients (12 of 24 patients had synovial effusion, p=0.008). Only 4 (17.4%) of 30 patients with DS had synovial effusion. When we investigate logistic regression results, we showed that the precence of facet joint effusion was odds ratio=8.706 fold higher in cases of synovial cysts (+). Chaput et al. [4] showed that patients with DS have significantly larger facet joint effusions than patients without DS. But in patients with severe facet joint osteoarthritis, despite clear anterolisthesis, no significant effusion was seen. This can be explained by the theory that as the degenerative process progresses from the phase of instability to the phase of restabilization, there should be a decrease in facet joint effusion. This theory may also explain the infrequent visualization of the communication between synovial cysts and the facet joints. The connection disappears and resolves while remodeling the advanced degeneration process. When a cyst loses its connection with the facet joint, it can migrate cranially or caudally from its original place. Our result supports this theory, as none of the cases with grade 3 facet joint osteoarthritis had visible communication between synovial cysts and the facet joints. The thickness of the flaval ligament was not significantly different in synovial cyst cases. Consequently, it is thought that the stress exposed by the flaval ligament was not differing. But the thesis must be supported by biomechanical studies.

Anterior synovial cysts are observed more frequently than posterior cysts [5, 9]. Doyle et al. [10] identified 7 anterior cysts (prevalence=2.3%) and 23 posterior cysts (prevalence=7.3%) in their retrospective MRI study, consisting of 303 MRI scans. We detected 17/24 (53.1%) anterior lumbar facet joint synovial cysts, and 10/24 (46.9%) posterior synovial cysts. The reason of the lower incidence of posterior cysts could be explained as, anterior cysts can lead to symptoms of canal narrowing or nerve compression, whereas posterior synovial cysts are usually asymptomatic. Subsequently, intraspinal synovial cysts tends to be symptommatic and have to be resected surgically.

There are several limitations to our study. Our findings are limited to only MRI findings. Many of the patients were referred from outside the hospital therefore correlation with clinical findings lacks. MRI is often the initial step in the evaluation of low back pain and radiculopathy, the accuracy to diagnose the synovial cysts is high, however MRI may underestimate spondylolisthesis. Bilateral increase in the facet joint fluid level on T2 transverse scans should alert the investigator to the

possibility of incompetent joints [12]. Standing lateral flexion-extension radiographs may be added to detect lumbar instability. Dynamic MRI would detect some missed spondylolisthesis, but as our study is a retrospective one, we could not obtain the aforementioned scans. Despite continuous development of MR imaging equipment, further studies are needed before the true management value of the techniques can be determined.

Another limitation is that none of the cysts in this series was validated surgically. However, the MRI features of lumbar synovial cysts are quite characteristic, and rarely could they be confused with some other entity. The use of a single observer might be seen as another weakness.

In this study, patients with facet joint synovial cysts were compared with patients with DS in terms of facet joint osteoarthritis, disc degeneration, facet joint effusion, and the thickness of the flaval ligament. The presence of synovial effusion and the high degree of disc degeneretion were observed in the patients with synovial cysts. Advanced osteoarthritis of the facet joints probably result from disconnection of the synovial cysts. Although osteoarthritis and DS are highly concomitant with facet joint synovial cysts, both conditions do not invariably lead to a cyst formation.

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