

Original Research Article

Investigating the correlation between facet joint fluid and instability in degenerative lumbar disease on flexion and extension radiographs: a retrospective study

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ABSTRACT

Background: Degenerative lumbar disease is a leading cause of chronic low back pain and disability. While flexion-extension radiographs are traditionally used to assess spinal instability, they can underestimate subtle instabilities. Facet joint effusion detected on magnetic resonance imaging (MRI) has been proposed as a dynamic indicator of biomechanical instability, but its diagnostic utility and practical thresholds require further validation. Objectives were to investigate the correlation between the presence of facet joint fluid and spinal instability in patients with degenerative lumbar disease using dynamic flexion and extension radiographs.

Methods: A retrospective study was conducted involving 132 patients diagnosed with degenerative lumbar disease. Imaging evaluations included supine MRI to assess facet joint fluid and upright flexion-extension radiographs to measure dynamic motion. Radiographic instability was defined as a sagittal translation greater than 3 mm or a segmental angulation greater than 20°. Clinical symptoms, such as pain location and duration, were also evaluated.

Results: Of the 132 patients, 66 (50.0%) exhibited bilateral facet fluid, 32 (24.2%) had unilateral fluid, and 34 (25.8%) showed no facet fluid. Patients with bilateral facet fluid demonstrated the highest facet fluid index (0.58 ± 0.04) and dynamic motion index (5.3 ± 1.2), along with a greater slip percentage in flexion ($8.4 \pm 1.1\%$). A striking association was observed between facet fluid presence and radiographic instability. Among patients with bilateral fluid, 93.9% had a sagittal translation >3 mm and 89.4% had an angular motion >20°. Furthermore, facet fluid presence significantly influenced clinical presentation, with 83.3% of patients with bilateral fluid reporting bilateral pain.

Conclusions: The accumulation of facet joint fluid, particularly bilateral effusion, is strongly correlated with measurable radiographic spinal instability and specific clinical symptoms in degenerative lumbar disease. These findings suggest that MRI-detected facet fluid may serve as a useful adjunctive imaging marker of dynamic instability, providing valuable insights for early detection and surgical planning.

Keywords: Degenerative lumbar disease, Facet joint fluid, Spinal instability, Flexion-extension radiographs, Magnetic resonance imaging, Lumbar spine, Facet effusion

INTRODUCTION

Lumbar degenerative disease may affect individuals across a broad age spectrum. Patients with degenerative lumbar

disease may present with low back pain, radiculopathy, or neurogenic claudication. In patients whose symptoms persist despite conservative management, the presence of radiographic instability may influence surgical decision-making.¹⁻⁴

Dynamic lumbar instability is defined as >3 mm sagittal translation or >20 degree segmental angulation.⁵

Standing flexion/extension lumbar spine X-rays are useful for detecting dynamic spondylolisthesis, which may be underestimated on supine MRI.⁶⁻⁸

MRI is the preferred non-invasive imaging modality for evaluating patients with lumbar radiculopathy and neurogenic claudication, as it provides detailed assessment of the spinal canal, neural structures, intervertebral discs, and degenerative changes of the lumbar spine.^{1,6,7}

Lumbar spinal stability refers to the ability of the lumbar spine to tolerate displacement during normal physiological postures and loads without generating nociceptive stimuli.⁹ Lumbar stability is maintained through the interaction of passive, active, and neural control subsystems; compromise of these subsystems may result in abnormal spinal motion.¹⁰

MRI alone is insufficient for the diagnosis of lumbar instability as 17% of patients who have instability on simple lateral radiograph did not have fluid signal on MRI and 7% patients who had a facet fluid signal on MRI did not have instability on simple lateral radiographs.^{7,11,12}

Previous studies have demonstrated an association between facet joint effusion on MRI and dynamic lumbar instability. In particular, the presence and greater extent of facet fluid on axial T2-weighted MRI have been associated with greater dynamic vertebral translation and an increased likelihood of radiographic instability.¹²⁻¹⁴

Studies have also examined whether the distribution and amount of effusion relate to instability, MRI-based proxies for segmental instability, and degenerative facet changes.¹⁵⁻¹⁷ A population-based cohort found no significant association between facet effusion and low-back pain or L4 spondylolisthesis.¹⁸ A comparative study likewise found no statistically significant association between larger effusions and instability in its main analysis, although an association was seen in the subgroup with L4-L5 degenerative spondylolisthesis.¹⁹ Other work has considered facet effusion as a clue to instability and its relationship with facet joint opening on CT.^{20,21}

Following study was designed to investigate the correlation between facet joint fluid and instability in degenerative lumbar spine disease.

METHODS

This retrospective study was conducted at the Department of Orthopaedics, Seth GS Medical College and KEM Hospital, Mumbai, Maharashtra, India after institutional ethics committee (IEC) approval over 24 months. The study included only those patients who had L4-L5, L5-S1 lumbar degenerative disease and whose flexion-extension radiographs, traditional lateral flexion-extension

radiographs, and MRI was obtained, and the time interval among the 3 types of examinations was no more than 1 month.

Patients were excluded if they had undergone previous lumbar spine surgery; if the interval between MRI and flexion-extension radiographs exceeded one month.¹² If they had lumbosacral disease of non-degenerative etiology (e.g., trauma, tumour, or infection); if they had skeletal dysplasia, including spina bifida occulta; if they had severe osteoporosis (T-score ≤ -2.5); if they had inflammatory spinal disorders such as ankylosing spondylitis or rheumatoid arthritis; if they had received spinal injections within three months before imaging; or if they were unable to perform flexion-extension radiographs because of pain or neuromuscular conditions. The study duration was 24 months. The sample size was calculated using the standard Cochran's formula for estimation of sample size with a confidence interval (CI) of 95% and Margin of error 5%.

The average number of patients coming weekly to our OPD approximated to be 200. Considering the 3.63% Incidence of lumbar degenerative disease worldwide according to a study by Ravindra et al the sample size for our study was calculated to be 132.²²

The study was approved by the IEC of Seth GS Medical College and KEM Hospital, Mumbai, Maharashtra, India, which waived the requirement for informed consent. A MRI of the lumbar spine with whole-spine screening was performed along with flexion-extension standing radiographs to confirm or refute dynamic lumbar instability along with the lumbar degenerative disease.

The facet fluid index was measured using axial images of the respective levels of MRI. The facet fluid index was calculated using axial T2-weighted MRI images, as illustrated in Figure 2.

Dynamic lumbar instability was defined as >3 mm sagittal translation or >20 -degree segmental angulation.⁵ Segmental translation and angulation were measured on flexion-extension radiographs as illustrated in Figure 1.

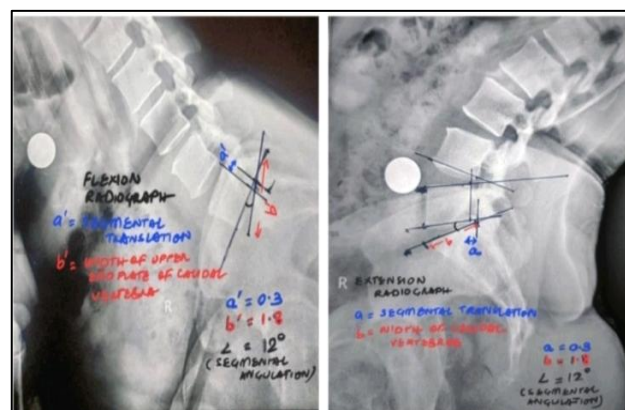


Figure 1: Segmental translation and angulation were measured on flexion-extension radiographs.



Figure 2: The facet fluid index was calculated on axial T2-weighted MRI.

Age, gender, address, occupation, segmental angulation, sagittal translation, and facet fluid index (mean width of fluid/mean width of superior and inferior facets) were obtained and entered in the case record form.

RESULTS

The study included 132 patients, with a mean age of 56.2 ± 12.4 years. The largest age group was 61-70 years (31.1%), followed by 51-60 years (26.5%). There were 65 males (49.2%) and 67 females (50.8%). Bilateral lower-limb pain was the most common clinical presentation (77 patients, 58.3%), followed by non-lateralized low-back pain (35 patients, 26.5%) and unilateral lower-limb pain (20 patients, 15.2%).

The facet fluid index was highest in the bilateral-fluid group (0.58 ± 0.04), followed by the unilateral-fluid group (0.46 ± 0.03) and the no-fluid group (0.36 ± 0.04 ; $p < 0.001$).

Flexion slip percentage was also highest in the bilateral-fluid group ($8.4 \pm 1.1\%$), compared with $6.6 \pm 0.7\%$ and $5.5 \pm 0.6\%$ in the unilateral- and no-fluid groups, respectively. The dynamic motion index followed the same pattern (5.3 ± 1.2 , 2.4 ± 0.9 , and 0.7 ± 0.5 , respectively; $p < 0.001$). Extension slip was lower in the bilateral-fluid group ($3.1 \pm 0.5\%$) than in the unilateral-fluid ($4.2 \pm 0.4\%$) and no-fluid groups ($4.7 \pm 0.4\%$).

Sagittal translation greater than 3 mm was present in 62 of 66 patients (93.9%) with bilateral facet fluid, compared with 12 of 32 (37.5%) with unilateral fluid and 6 of 34 (17.6%) without fluid. Angular motion greater than 20° was observed in 59 patients (89.4%) in the bilateral-fluid group, 8 (25.0%) in the unilateral-fluid group, and 4 (11.8%) in the no-fluid group. Both associations were statistically significant ($p < 0.001$).

Bilateral lower-limb pain was reported by 55 of 66 patients (83.3%) with bilateral facet fluid. In the unilateral-fluid group, bilateral and unilateral lower-limb pain were each reported by 12 patients (37.5%). Among patients without facet fluid, non-lateralized low-back pain was the most common presentation, occurring in 20 of 34 patients (58.8%).

Symptoms lasting more than 3 months were reported by 58 of 66 patients (87.9%) with bilateral facet fluid, 16 of 32 (50.0%) with unilateral fluid, and 10 of 34 (29.4%) without fluid. In the no-fluid group, symptoms lasting less than 6 weeks were most common (16 patients, 47.1%). Thus, longer symptom duration was more frequent in the bilateral-fluid group.

Bilateral facet joint fluid was observed in 66 patients (50.0%), unilateral facet joint fluid in 32 patients (24.2%), and no facet joint fluid in 34 patients (25.8%). Bilateral facet joint fluid was therefore the most frequent pattern in the study population.

Table 1: Patient demographics and baseline characteristics.

Characteristics	ValueS
Total patients	132
Age, mean$\pm$SD (in years)	56.2 ± 12.4
Age group (in years)	
31-40	16 (12.1%)
41-50	21 (15.9%)
51-60	35 (26.5%)
61-70	41 (31.1%)
>70	19 (14.4%)
Sex	
Male	65 (49.2%)
Female	67 (50.8%)
Clinical presentation	
Bilateral lower limb pain	77 (58.3%)
Non-lateralized low back pain	35 (26.5%)
Unilateral lower limb pain	20 (15.2%)

Table 2: Distribution of facet joint fluid.

Category	N	P value
Bilateral	66 (50.0%)	N/A
Unilateral	32 (24.2%)	
None	34 (25.8%)	

Table 3: Correlation with radiographic instability parameters.

Radiographic parameter	Total, (n=132)	Bilateral, (n=66)	Unilateral, (n=32)	None, (n=34)	P value
Facet fluid index	0.49±0.09	0.58±0.04	0.46±0.03	0.36±0.04	<0.001
Slip% (flexion)	7.2±1.6	8.4±1.1	6.6±0.7	5.5±0.6	<0.001
Slip% (extension)	3.8±0.8	3.1±0.5	4.2±0.4	4.7±0.4	<0.001
Dynamic motion index	3.4±2.3	5.3±1.2	2.4±0.9	0.7±0.5	<0.001

Table 4: Association between facet fluid presence and radiographic instability criteria.

Instability criteria	Facet fluid presence	Total, (n=132)	Bilateral, (n=66)	Unilateral, (n=32)	None, (n=34)	P value
Sagittal translation >3 mm	Yes	80 (60.6%)	62 (93.9%)	12 (37.5%)	6 (17.6%)	<0.001
	No	52 (39.4%)	4 (6.1%)	20 (62.5%)	28 (82.4%)	
Angular motion >20°	Yes	71 (53.8%)	59 (89.4%)	8 (25.0%)	4 (11.8%)	<0.001
	No	61 (46.2%)	7 (10.6%)	24 (75.0%)	30 (88.2%)	

Table 5: Correlation with clinical symptoms.

Pain location	Facet fluid presence			
	Total, (n=132)	Bilateral, (n=66)	Unilateral, (n=32)	None, (n=34)
Bilateral lower limb	77 (58.3%)	55 (83.3%)	12 (37.5%)	10 (29.4%)
Unilateral lower limb	20 (15.2%)	4 (6.1%)	12 (37.5%)	4 (11.8%)
Lower back	35 (26.5%)	7 (10.6%)	8 (25.0%)	20 (58.8%)

Table 6: Pain duration.

Pain duration	Facet fluid presence			
	Total, (n=132)	Bilateral, (n=66)	Unilateral, (n=32)	None, (n=34)
<6 weeks	18 (13.6%)	0(0%)	2 (6.3%)	16 (47.1%)
6-12 weeks	30 (22.7%)	8 (12.1%)	14(43.8%)	8 (23.5%)
>3 months	84 (63.6%)	58 (87.9%)	16 (50.0%)	10 (29.4%)

DISCUSSION

The present study demonstrated a strong association between facet joint fluid on MRI and radiographic lumbar instability in patients with degenerative lumbar disease. The association was particularly pronounced in patients with bilateral facet joint fluid, in whom 93.9% demonstrated sagittal translation >3 mm and 89.4% demonstrated angular motion >20°. Furthermore, the bilateral fluid group demonstrated the highest facet fluid index and dynamic motion index. These findings support the role of facet joint effusion as an adjunctive imaging marker of dynamic instability. Previous studies have similarly demonstrated an association between facet fluid and dynamic lumbar instability, although the strength of this association has varied according to the definition of instability and the imaging technique used. Cho et al

reported that facet fluid signal on T2-weighted MRI was significantly more frequent and greater in patients with radiographic instability.¹¹ While Wang et al demonstrated an association between the facet fluid sign and dynamic spondylolisthesis using kinematic MRI.²³

Facet joint fluid and sagittal translation

In the present study, 93.9% (62/66) of patients with bilateral facet joint fluid demonstrated sagittal translation >3 mm, compared with 37.5% of patients with unilateral fluid and 17.6% of patients without facet fluid. This strong association is consistent with previous studies. Rihn et al reported a close linear relationship between the facet fluid index and the amount of radiographic instability at L4-L5, with a Pearson correlation coefficient of 0.90.¹² Cho et al similarly found a significant association between facet

fluid signal on T2-weighted MRI and instability on standing radiographs, with a positive predictive value of 93.22%.¹¹ Snoddy et al further demonstrated that increasing facet fluid was associated with an increasing probability of dynamic instability; each 1-mm increase in facet fluid was associated with a 41.6% increase in the odds of dynamic instability.²⁴ A systematic review and meta-analysis by Aggarwal and Garg involving 14 studies and 1,065 patients reported pooled odds of 7.55 for unstable degenerative spondylolisthesis in the presence of facet fluid, with the probability of dynamic spondylolisthesis increasing as the size of the facet fluid increased.¹⁴ Thus, the very high prevalence of sagittal translation observed in our bilateral-fluid group is consistent with the broader literature supporting facet effusion as an indicator of dynamic instability.

Facet joint fluid and angular motion

The present study also demonstrated a significant association between facet fluid and angular instability, with 89.4% of patients with bilateral facet fluid demonstrating segmental angular motion $>20^\circ$, compared with 25.0% of patients with unilateral fluid and 11.8% of patients without fluid. Previous investigations have generally focused more on translational instability than on a specific angular threshold. Wang et al using kinematic MRI, demonstrated significant differences in angular motion and other measures of segmental movement between patients with positive and negative facet fluid signs.²³ The authors also found that the facet fluid sign was more frequently present in dynamic than static spondylolisthesis. These findings complement our results by suggesting that facet effusion is associated not only with anterior-posterior translation but also with abnormal segmental motion. However, because previous studies have used different definitions and measurement techniques for angular instability, direct comparison with our $>20^\circ$ threshold should be made cautiously.

Facet fluid index and degree of effusion

A progressive increase in the facet fluid index was observed in our study according to the extent of facet fluid: 0.58 ± 0.04 in the bilateral group, 0.46 ± 0.03 in the unilateral group, and 0.36 ± 0.04 in patients without fluid ($p < 0.001$). This finding is consistent with previous evidence that the amount of facet fluid, rather than merely its presence or absence, may be related to the degree of instability. Rihn et al demonstrated a strong linear relationship between facet fluid index and radiographic instability.¹² Snoddy et al also reported that increasing facet fluid was associated with increasing odds of dynamic instability.²⁴ Similarly, the systematic review and meta-analysis by Aggarwal and Garg, found that larger facet-fluid measurements were associated with dynamic degenerative spondylolisthesis and reported that the probability of dynamic spondylolisthesis increased as facet-fluid size increased.¹⁴ Our findings therefore support a quantitative relationship between the extent of facet joint fluid and abnormal

segmental motion. The particularly high index observed in the bilateral-fluid group may further indicate that bilateral effusion represents a more advanced manifestation of the same instability process.

Slip percentage and dynamic motion

Patients with bilateral facet fluid in our study demonstrated the greatest dynamic motion index (5.3 ± 1.2) and the greatest slip percentage during flexion ($8.4 \pm 1.1\%$). The dynamic motion index and flexion slip progressively decreased in the unilateral and no-fluid groups. Conversely, extension slip showed an inverse relationship, with the bilateral group demonstrating $3.1 \pm 0.5\%$ compared with $4.2 \pm 0.4\%$ in the unilateral group and $4.7 \pm 0.4\%$ in the no-fluid group. Wang et al reported significant differences in translational motion and flexion-extension slip difference between patients with positive and negative facet fluid signs, supporting the relationship between facet fluid and abnormal segmental kinematics.²³ Lattig et al similarly investigated facet effusion in relation to abnormal motion between upright radiographs and supine MRI in degenerative spondylolisthesis.¹³ The present findings therefore extend previous observations by demonstrating significant differences in several quantitative measures of dynamic motion according to the presence and laterality of facet fluid. Because the dynamic motion index used in our study is not uniformly reported in previous studies, direct numerical comparison is not possible; nevertheless, the direction of association is consistent with existing evidence.

Facet fluid and clinical presentation

In our study, facet fluid was also associated with the clinical presentation. Among patients with bilateral facet fluid, 83.3% reported bilateral lower-limb pain, whereas patients without facet fluid predominantly reported non-lateralized lower-back pain. Chronic symptoms lasting >3 months were also more frequent in the bilateral-fluid group (87.9%), while acute symptoms lasting <6 weeks were more common among patients without facet fluid (47.1%). These findings suggest that greater facet effusion and radiographic instability may coexist with a more chronic and neurologically symptomatic clinical presentation. However, this relationship should be interpreted cautiously because facet effusion is not specific for the patient's pain generator. Snoddy et al found an association between facet fluid, dynamic instability and improvement in low-back pain following fusion, although their study did not establish facet fluid as a direct cause of symptoms.²⁴ More recently, a 2026 study by Zhao et al reported higher pain scores in patients with facet joint effusion and demonstrated an association between quantitatively measured effusion and dynamic instability.²⁵ Thus, our findings provide additional evidence that facet effusion may have clinical relevance, although prospective studies are required to establish whether the presence or amount of facet fluid independently predicts symptom severity.

Clinical implications

The findings of the present study suggest that facet joint fluid on routine supine MRI may serve as a useful adjunctive marker for identifying patients who may have dynamic lumbar instability. This is particularly relevant because conventional MRI is obtained in the supine position and may not demonstrate the full extent of motion-dependent vertebral translation. Cho et al demonstrated that facet fluid signal should raise suspicion for instability and recommended additional evaluation with stress radiographs.¹¹ Similarly, Aggarwal and Garg, concluded that standing flexion-extension radiographs should be considered when facet fluid >1 mm is identified on MRI.¹⁴ However, facet effusion should not be considered a definitive diagnostic criterion or an independent indication for fusion. Lattig et al found that the presence of the facet effusion signs alone did not justify adding fusion to decompression in degenerative spondylolisthesis.¹³ Therefore, facet fluid should be interpreted together with standing flexion-extension radiographs, the degree of vertebral translation, angular motion, clinical symptoms and other degenerative changes when making surgical decisions.

Limitations

This study has several limitations. First, its retrospective design introduces the possibility of selection and information bias. Second, the study was conducted at a single Centre and included a relatively modest sample of 132 patients, which may limit the generalizability of the findings. Third, only patients with degenerative disease involving the L4-L5 and L5-S1 levels were included, and therefore the findings may not be applicable to other lumbar levels or other forms of spinal instability. Fourth, measurements of facet fluid, sagittal translation and segmental angulation may be subject to observer-related measurement variability. Finally, the study establishes an association between facet fluid and radiographic instability but does not establish a causal relationship or determine whether facet fluid independently predicts surgical outcomes. Prospective multicenter studies with standardized quantitative assessment and longitudinal clinical follow-up are required to validate these findings.

This retrospective analysis addresses the pressing need for adjunctive markers to standard dynamic radiographs. By establishing a robust correlation between fluid presence and measurable radiographic thresholds, the study standardizes the communication between radiologists and spine surgeons, reducing diagnostic variability and improving patient safety and operative planning.

CONCLUSION

In this study of 132 patients with lumbar degenerative disease, the presence of facet joint fluid on MRI, particularly bilateral facet joint fluid, was strongly associated with radiographic lumbar instability. Patients

with bilateral facet fluid demonstrated higher facet fluid indices, greater dynamic motion, and a substantially higher frequency of sagittal translation >3 mm and angular motion >20° compared with patients with unilateral or absent facet fluid. The findings suggest that facet joint effusion, especially when bilateral and quantitatively greater, may serve as a useful adjunctive imaging marker for identifying patients with potential dynamic lumbar instability. However, facet fluid should not be considered an independent diagnostic criterion or sole indication for surgical stabilization; it should be interpreted alongside dynamic radiographs, clinical findings, and other imaging parameters. This study adds quantitative evidence supporting the relationship between the extent of facet joint effusion and radiographic instability and may help improve the identification of dynamic instability in patients undergoing evaluation for degenerative lumbar disease.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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