MRI Assessment of Post-Operative Complications of Lumbar Spine Surgery

Ghada Mohamed Abdelrazek[a], Zeinab Omar Abdelmohsen Baghdadi[a*], Mohammed Ahmed Aboelyazeed Elghareeb[b], Ahmed M Khalaf-Awad[a]

[a] Department of Diagnostic and Interventional Radiology, Faculty of Medicine, Qena University, Qena, Egypt.
[b] Department of Neurosurgery, Faculty of Medicine, Qena University, Qena, Egypt.

Abstract

Background: Lower back pain is a common recurrent condition. The increasing number of lumbar spine surgeries has raised the incidence of postoperative complications, making early diagnosis essential. MRI is the preferred imaging modality because of its excellent soft-tissue visualization and diagnostic accuracy.

Objectives: To evaluate the role of MRI in detecting postoperative lumbar spine complications.

Patients and methods: This cross-sectional study included **50 patients** with postoperative lumbar spine complications at Qena University Hospital. All patients underwent clinical assessment and lumbar spine MRI using standardized **1.5T** T1- and T2-weighted protocols. Patients with MRI contraindications or who declined participation were excluded.

Results: The mean age was 47.98 ± 10.61 years; 68% were males. Lower back pain was the most common symptom (94%), and laminectomy (82%) was the most common procedure. MRI showed excellent agreement with surgical findings ($P < 0.0001$) except for arachnoiditis ($P = 0.494$). MRI achieved 100% accuracy for recurrent disc herniation and spondylodiscitis, 98% for spinal stenosis and abscess, and 90% for seroma and arachnoiditis. Sensitivities were 100%, 90%, 95.83%, 82.76%, and 60%, respectively.

Conclusion: MRI is a reliable and accurate modality for detecting postoperative lumbar spine complications, providing high diagnostic performance for most conditions and supporting early diagnosis and appropriate management despite lower accuracy for arachnoiditis.

Keywords: Magnetic resonance imaging (MRI); Lumbar spine surgery; Postoperative complications; Diagnostic accuracy; Postoperative lumbar spine.

DOI : 10.21608/SVUIJM.2026.522060.2473

***Correspondence:** zeinabomar25495@gmail.com

Received : 29 August, 2026.
Revised : 5 September, 2026.
Accepted : 13 September, 2026.
Published : 23 September, 2026.

Cite this article Ghada Mohamed Abdelrazek, Zeinab Omar Abdelmohsen Baghdadi, Mohammed Ahmed Aboelyazeed Elghareeb, Ahmed M Khalaf-Awad (2026) MRI Assessment of Post-Operative Complications of Lumbar Spine Surgery. *SVU-International Journal of Medical Sciences.* Vol.9, Issue 2, pp: 1071-1085.

Copyright: © Abdelrazek (2026) Immediate open access to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge. Users have the right to Read, download, copy, distribute, print or share link to the full texts under a Creative Commons BY-NC-SA 4.0 International License.

Introduction

Lower back pain is a common and major cause of morbidity in middle-aged and elderly individuals, with multiple underlying causes. Although most cases are self-limiting, recurrence rates can reach up to 85%, making it a frequent chronic condition. It significantly affects physical and psychological health, reduces work capacity and family involvement, and increases healthcare costs. With rising life expectancy and advances in medical care, the global burden of spinal disease has increased. In addition, modern surgical developments such as minimally invasive spine surgery, percutaneous pedicle screw fixation, and advanced imaging and navigation have greatly expanded spinal surgery use, which is now about 2.4 times higher than 15 years ago (**Sakaguchi et al., 2024**).

With the increase in spinal procedures, postoperative complications have become more clinically important. Early complications include instrument malposition, seroma, hematoma, pseudomeningocele, and infection, while long-term complications may involve osteolysis, failed fusion, adjacent segment disease, and epidural fibrosis. Accurate imaging interpretation is therefore essential for early and precise diagnosis to ensure effective management (**Park et al., 2024**).

MRI is the most effective modality for evaluating postoperative spinal complications due to its superior soft-tissue detail, allowing assessment of neural structures, bone marrow, and surrounding soft tissues. However, metal implants may cause susceptibility artifacts that reduce image quality. These can be minimized using technical adjustments such as higher bandwidth, modified imaging parameters, fat suppression techniques, and advanced metal artifact reduction methods like MAVRIC-SL (GE HealthCare®), WARP (Siemens Healthineers®), and SEMAC (Siemens Healthineers®), which significantly improve diagnostic accuracy (**Girão et al., 2023**).

This study aim to evaluate role of MRI in detecting complications of postoperative lumbar spine.

Patients and methods

This cross-sectional study was conducted in the Diagnostic and Interventional Radiology Department at Qena University Hospital. The study was approved by he local research ethical committee under the ethical approval code of SVU-MED-RAD028-1-24-1-784.

The study included all eligible patients in the period of the study. A total of 50 patients presenting with postoperative lumbar spine complications. Inclusion criteria comprised patients with confirmed postoperative lumbar spine complications. Patients were excluded if they had contraindications to MRI, including metallic implants, pacemakers, cochlear implants, or if they refused to participate.

All participants underwent detailed history taking and a complete physical examination to evaluate their overall health status.

MRI Protocol

MRI of the lumbar spine was performed using Philips Achieva 1.5T and Toshiba Aquilion 64-slice systems with a spinal coil. Imaging included multiple sequences with standardized parameters: sagittal T1-weighted images (TR/TE 424–709/8.4–12, 4.0 mm slice thickness, 0.4 mm gap), axial T1-weighted images (TR/TE 519–745/6.8–12, 3.0 mm thickness, 0.3–1.0 mm gap), sagittal T2-weighted images (TR/TE 3000–4301/92–120, 4.0 mm thickness, 0.4 mm gap), sagittal 3D T2-weighted images (TR/TE 1300–1500/133–148, 2.0 mm thickness, no gap), and axial T2-weighted images (TR/TE 2372–4247/88–120, 3.0 mm thickness, 0.3–1.0 mm gap).

Ethical approval code of SVU-MED-RAD028-1-24-1-784.

Statistical analysis

Data were collected, coded, and analyzed using the Statistical Package for the Social Sciences (SPSS), version 26.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were tested for normality and expressed as mean ± standard deviation (SD), while qualitative variables were presented as frequency (n) and percentage (%). Agreement between MRI findings and surgical exploration was assessed using the Kappa (κ) agreement test, and the level of statistical significance was determined using the corresponding P value. A P value < 0.05 was considered statistically significant. The diagnostic performance of MRI was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy, using surgical exploration as the reference standard.

Results

The study included 50 cases with a mean age of 47.98 ± 10.61 years. Regarding sex distribution, 34 patients (68%) were males and 16 (32%) were

females. Concerning residence, 28 cases (56%) were from urban areas, while 22 cases (44%) resided in rural areas.

Lower back pain was the most prevalent symptom, reported in 47 patients (94%). Unilateral sciatica was observed in 8 cases (16%), while bilateral sciatica occurred in 13 cases (26%). Paraplegia was present in 3 patients (6%), and fever was reported in 25 cases (50%) **(Fig 1)**. Among the 50 studied cases, laminectomy was the most frequently performed procedure, carried out in 41 patients (82%), followed by transpedicular fixation in 20 patients (40%) and discectomy in 6 patients (12%). The mean operative duration was 115.98 ± 16.14 minutes. **(Table 1)**

There was strong agreement between MRI and surgical exploration in all postoperative lumbar spine complications (P<0.0001) except for arachnoiditis there was no significant association (P=0.494). Recurrent disc herniation was 3 cases (6%) on both modalities, and spondylodiscitis was 14 cases (28%) on both, showing complete concordance. Spinal stenosis showed a slight decrease on MRI with 9 cases (18%) compared to 10 cases (20%) on exploration. Abscess was also slightly lower on MRI with 23 cases (46%) versus 24 cases (48%) on exploration. Seroma showed a more marked reduction on MRI, detected in 24 cases (48%) compared to 29 cases (58%) on exploration. Arachnoiditis showed a slight increase on MRI with 6 cases (12%) compared to 5 cases (10%) on exploration with no significant association indicating variability between both methods. **(Table 2)**

For spinal stenosis, sensitivity decreased to 90%, while specificity and PPV remained 100%. The NPV was 97.56% and overall accuracy was 98%, indicating a slight increase in missed cases compared to surgical findings. In abscess detection, MRI showed high performance with 95.83% sensitivity, 100% specificity and PPV, 96.3% NPV, and 98% accuracy, reflecting only a minimal reduction in sensitivity. For seroma, diagnostic performance declined, with sensitivity of 82.76%, specificity and PPV of 100%, NPV of 80.77%, and accuracy of 90%, indicating a noticeable decrease in detection rate. Arachnoiditis showed the lowest performance, with sensitivity of 60%, specificity of 93.33%, PPV of 50%, NPV of 95.45%, and overall accuracy of 90%, reflecting a marked reduction in diagnostic reliability. **(Table 3)**

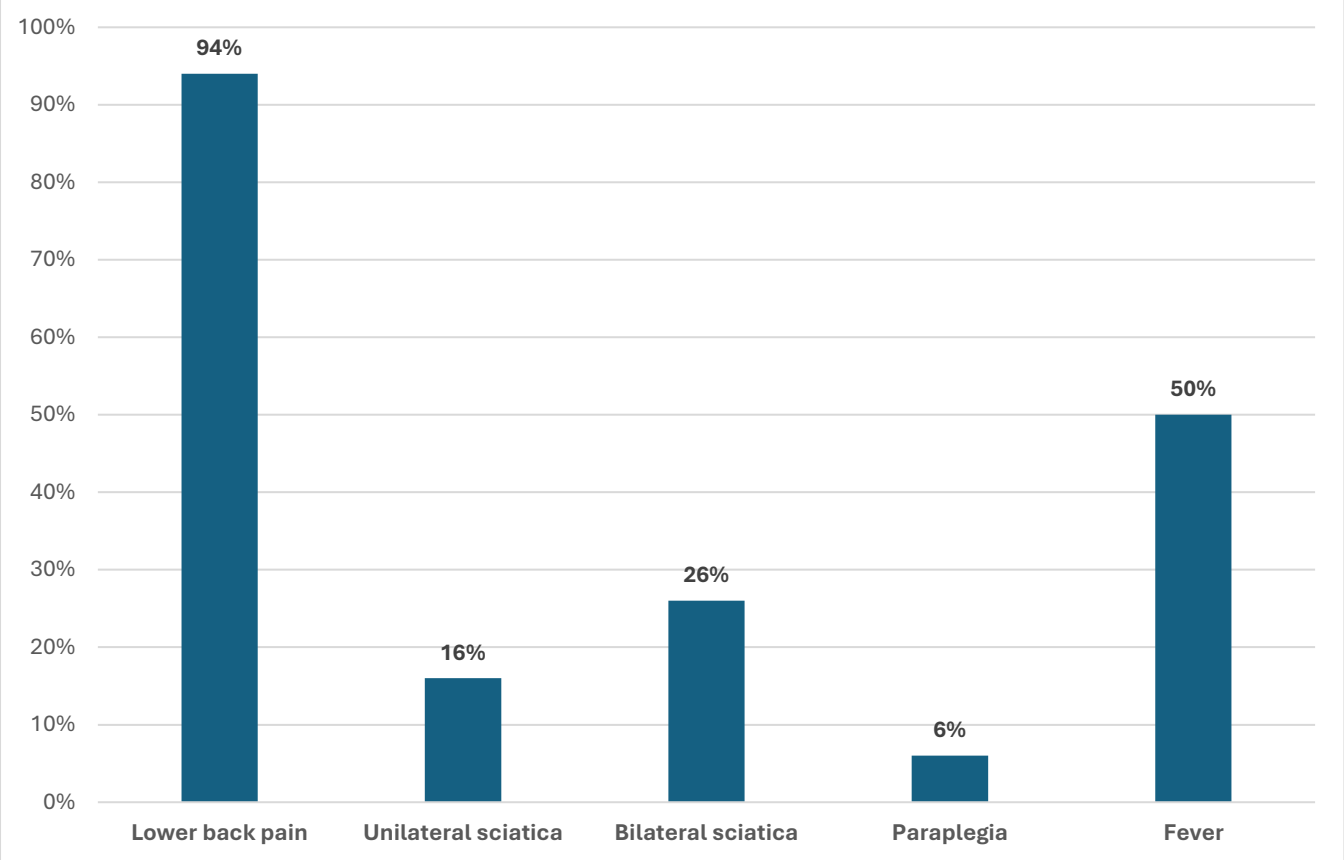


Fig 1. Main symptoms among the studied cases.

Table (1). Operative data among the studied cases

variables	All cases (N = 50)
Type of operation	
• **Laminectomy**	41 (82%)
• **transpedicular fixation**	20 (40%)
• **Discectomy**	6 (12%)
Operative duration (min)	115.98 ± 16.14

Table (2). Relation between Exploration and MRI Findings among the studied cases

Variables	Exploration (N = 50)	MRI (N = 50)	P. Value[k]
Recurrent disc herniation	3 (6%)	3 (6%)	<0.0001*
Spondylodiscitis	14 (28%)	14 (28%)	<0.0001*
Spinal stenosis	10 (20%)	9 (18%)	<0.0001*
Abscess	24 (48%)	23 (46%)	<0.0001*
Seroma	29 (58%)	24 (48%)	<0.0001*
Arachnoiditis	5 (10%)	6 (12%)	0.494

k: Kappa agreement

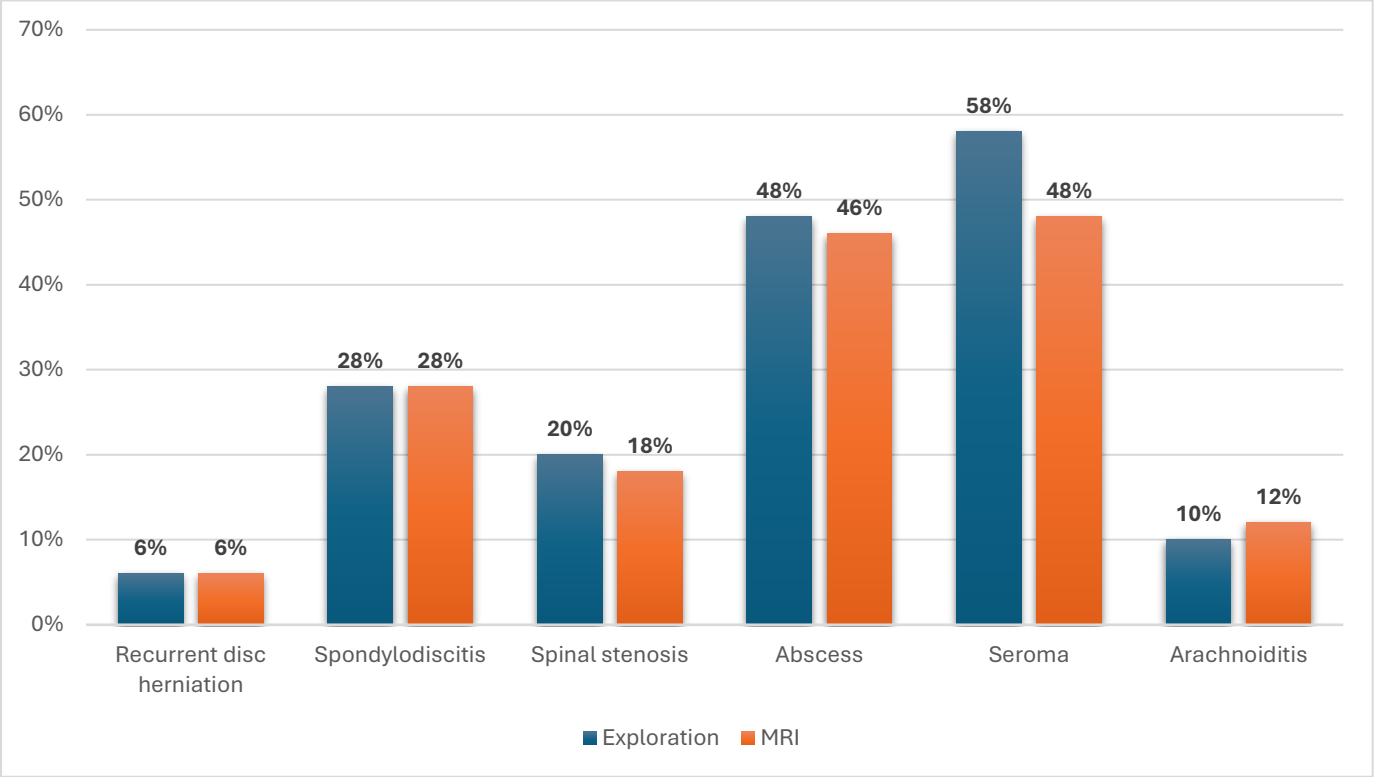


Fig 2. Relation between Exploration and MRI Findings among the studied cases

Table (3). Diagnostic accuracy of MRI for detection of postoperative complications

Variables	Sensitivity	Specificity	PPV	NPV	Accuracy
Recurrent disc herniation	100%	100%	100%	100%	100%
Spondylodiscitis	100%	100%	100%	100%	100%
Spinal stenosis	90%	100%	100%	97.56%	98%
Abscess	95.83%	100%	100%	96.3%	98%
Seroma	82.76%	100%	100%	80.77%	90%
Arachnoiditis	60%	93.33%	50%	95.45%	90%

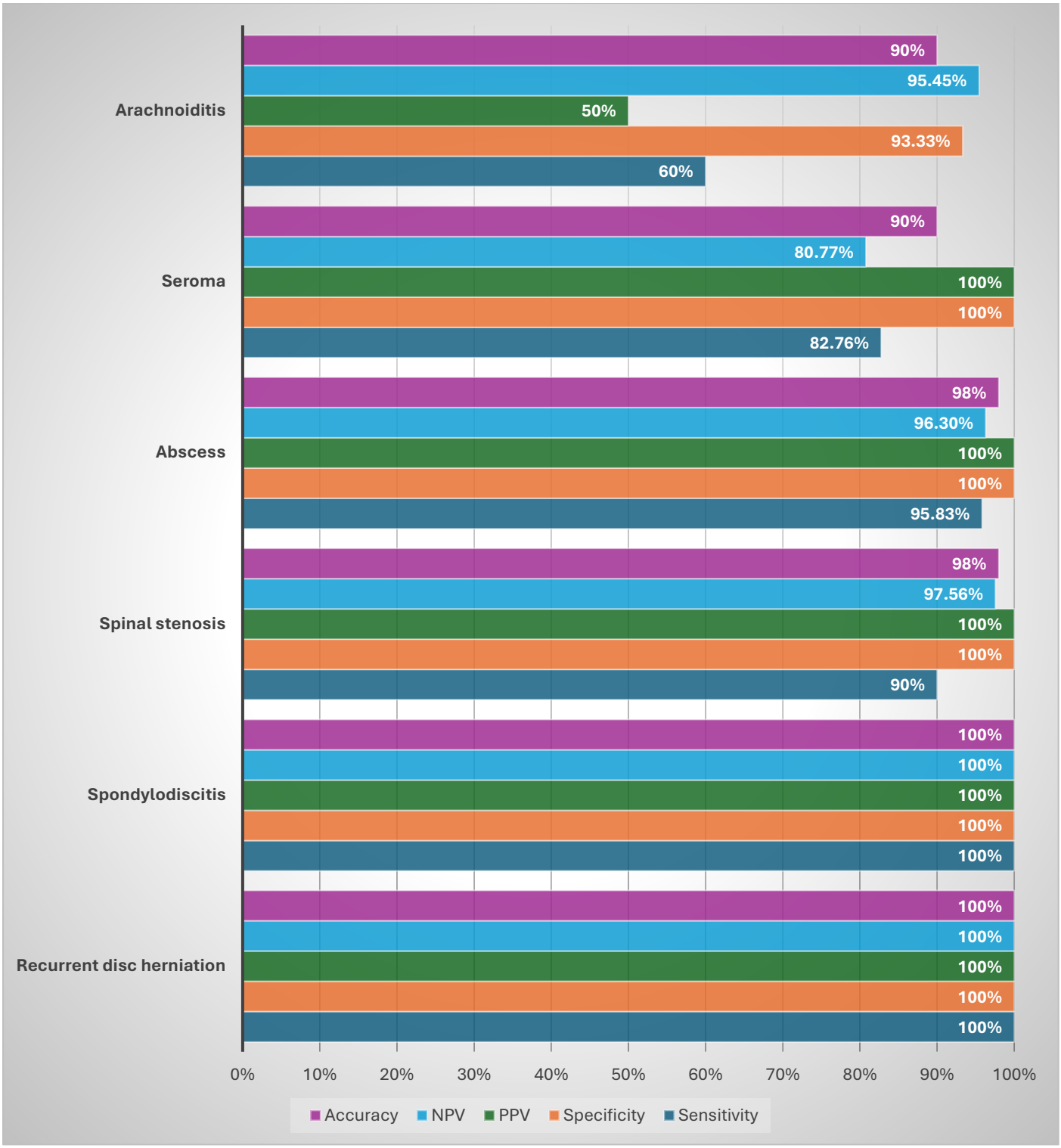


Fig 3. Diagnostic accuracy of MRI for detection of postoperative complications

Cases presentation

Case (1)

A 37-year-old female patient underwent L4–L5 spinolaminectomy three weeks ago for L4–L5 disc herniation. She now presents with severe lower back pain radiating to both lower limbs. MRI demonstrates abnormal signal intensity at the L4–L5 level with subendplate bone marrow edema and involvement of the intervening disc, along with a large operative bed lesion measuring approximately 8 × 8 × 6 cm. The lesion is hypointense on T1WI and hyperintense on T2WI and STIR sequences. These findings are associated with an operative bed seroma, confirmed by aspiration yielding straw-colored fluid, as well as concurrent L4–L5 spondylodiscitis.

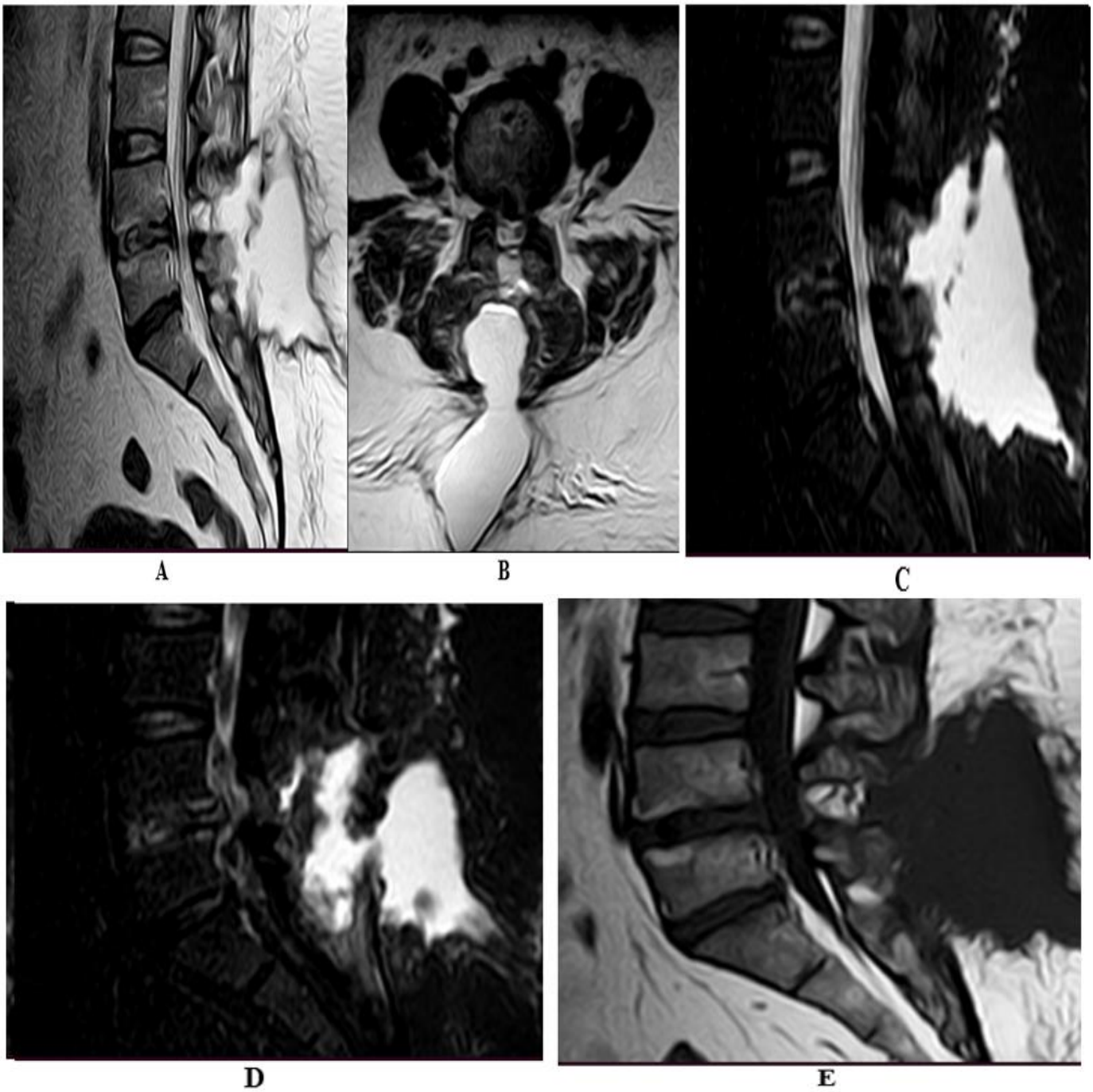


Fig 1. (A) Sagittal, (B)Axial T2WI lumbarspine MRI, (C) and (D) Sagittal STIR MRI images, showing operative bed hyperintense signal of fluid intensity with abnormal signal intensity of L4-5 sub endplates and intervening disc,(E)Sagittal T1WI MRIimageshowing hypointense signal of the lesion.

Case (2)

A 44-year-old male patient with a history of disc herniation underwent L4–L5 laminectomy six weeks ago. He now presents with recurrent lower back pain and bilateral sciatica. MRI pre- and post-contrast sequences demonstrate a localized fluid collection at the operative site near the L4 spinous process, measuring approximately 45 × 40 × 21 mm. The lesion is hypointense on T1WI and hyperintense on T2WI and STIR sequences, with adjacent foci of hemorrhage showing hyperintensity on both T1WI and T2WI. There is associated post-contrast enhancement of the surrounding muscular tissue. These findings are consistent with an infected postoperative seroma with postoperative inflammatory changes.



Fig 2. (A) axial and (B) sagittal T2WI, (C) Sagittal STIR lumbar spine MRI images showing ill defined hyperintense signal seen at operative bed (localized collection), (D) axial T1WI lumbar MRI image showing hypointense signal of the lesion with hyperintense foci within, (E)Axialpost contrast T1WI FAT SAT MRI showing enhancement of the surrrounding soft tissue with hyperintense foci adjacent to the lesion.

Case (3)

A 47-year-old female patient with a history of disc herniation underwent L4–L5 discectomy with left laminectomy five weeks ago. She now presents with lower back pain. MRI pre- and post-contrast sequences demonstrate degenerative changes of the left L5–S1 facet joint, surrounded by ill-defined soft tissue thickening, edema, and a localized collection that is hypointense on T1WI and hyperintense on T2WI and STIR sequences, with peripheral post-contrast enhancement. There is also abnormal signal intensity involving the L4–L5 and L5–S1 vertebral endplates and corresponding disc spaces, showing mild post-contrast enhancement. These findings are consistent with left L5–S1 facet joint septic arthritis with associated discitis.

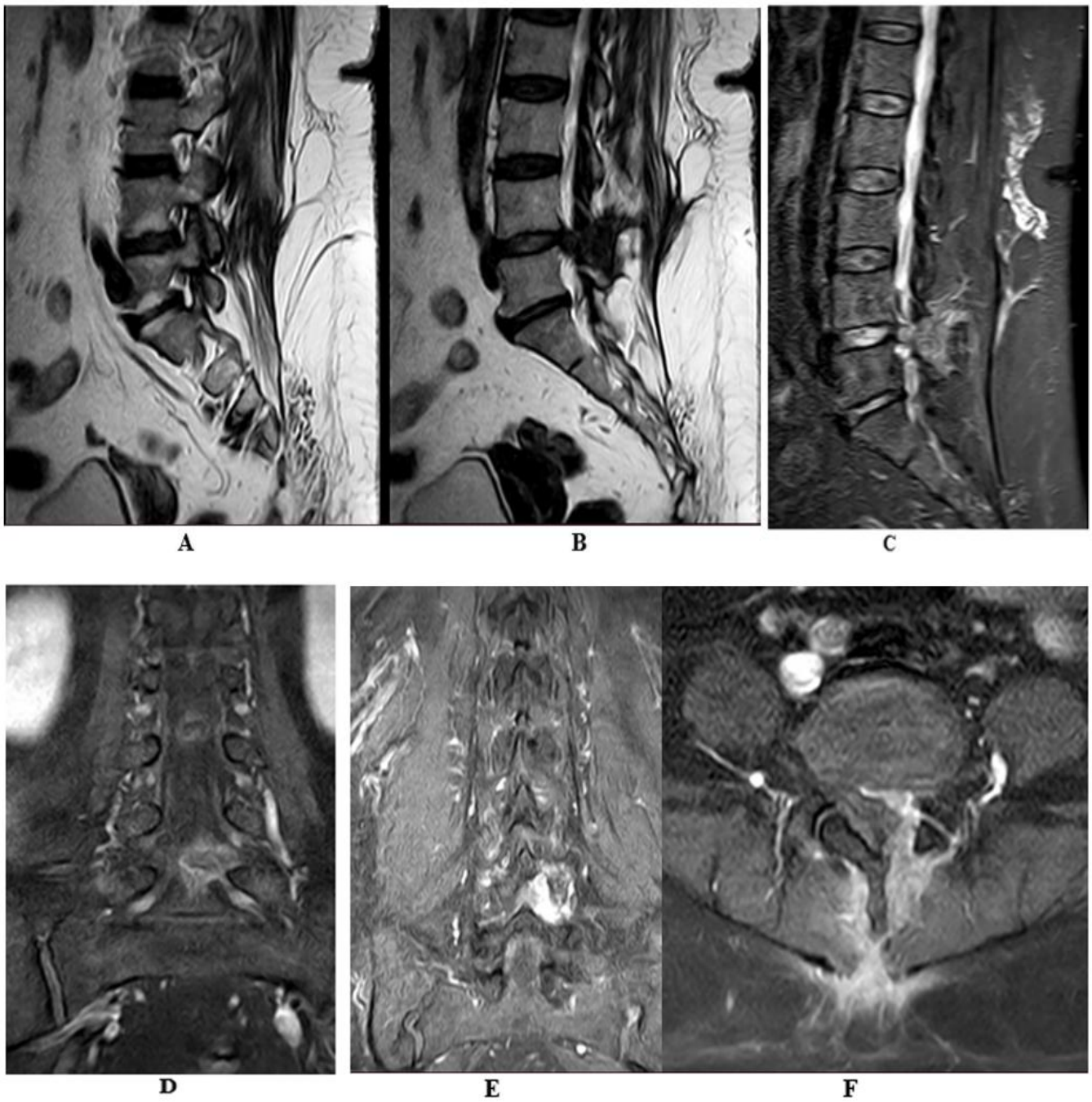


Fig 3. (A) and (B) sagittal T2WI lumbar spine MRI images, (C) Sagittal STIR MRI imageshowinglocalized collection at left facet joint exihibiting hyperintense signal surrounding by soft tissue edema.,hyperintese signal of L4-5 and L5-S1 vertebral endplates (fig A). (D) and (E) coronal and (F) axial post contrast FAT SAT T1WI images showing peripheral enhancement of the collection.

Case (4)

A 62-year-old male patient with a history of post-traumatic spinal injury underwent transpedicular screw fixation at L3, L4, and L5 levels 1.5 years ago. He now presents with lower back pain and mild fever. MRI pre- and post-contrast sequences reveal an extracanalicular, intramuscular branching fluid collection predominantly in the left paramidline region, extending from the L2 to S1 disc levels, with an associated sinus tract at the L4–L5 level. The lesion is hypointense on T1WI and hyperintense on T2WI and STIR sequences, showing peripheral ring enhancement after contrast administration and surrounded by soft tissue edema. These findings are consistent with L4–L5 spondylodiscitis complicated by a large postoperative bed abscess with sinus tract formation.

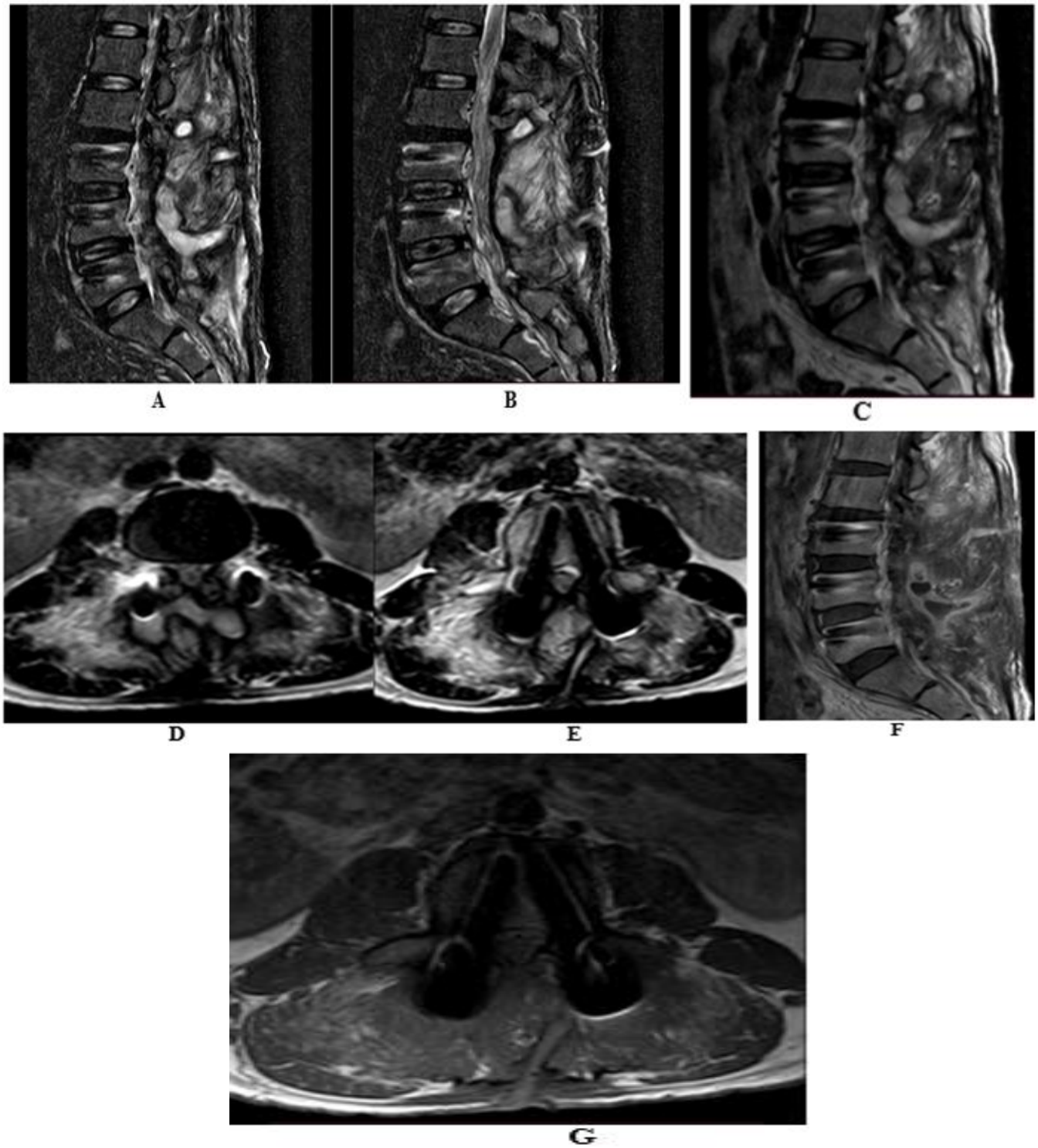


Fig 4. (A) and (B) Sagittal STIR lumbar spine MRI images, (C) SagittalT2WI MRI (D) and (E) AxialT2 MRI, showingextracanalicular intramuscular branching localized collection with sinus tract (F) and (G) Sagittal andaxial post contrast T1WI FAT SAT MRI showing peripheral enhancement of the collection and sinus tract.

Case (5)

A 52-year-old female patient with a history of disc herniation underwent L5 spinolaminectomy three months ago. She now presents with lower back pain. MRI shows a localized operative bed fluid collection extending intramuscularly and appearing connected to the spinal canal at the L5–S1 level, measuring approximately 4 × 2 × 9 cm. The lesion is hyperintense on T2WI and hypointense on T1WI sequences. These findings are consistent with a postoperative seroma, confirmed by aspiration yielding straw-colored fluid.

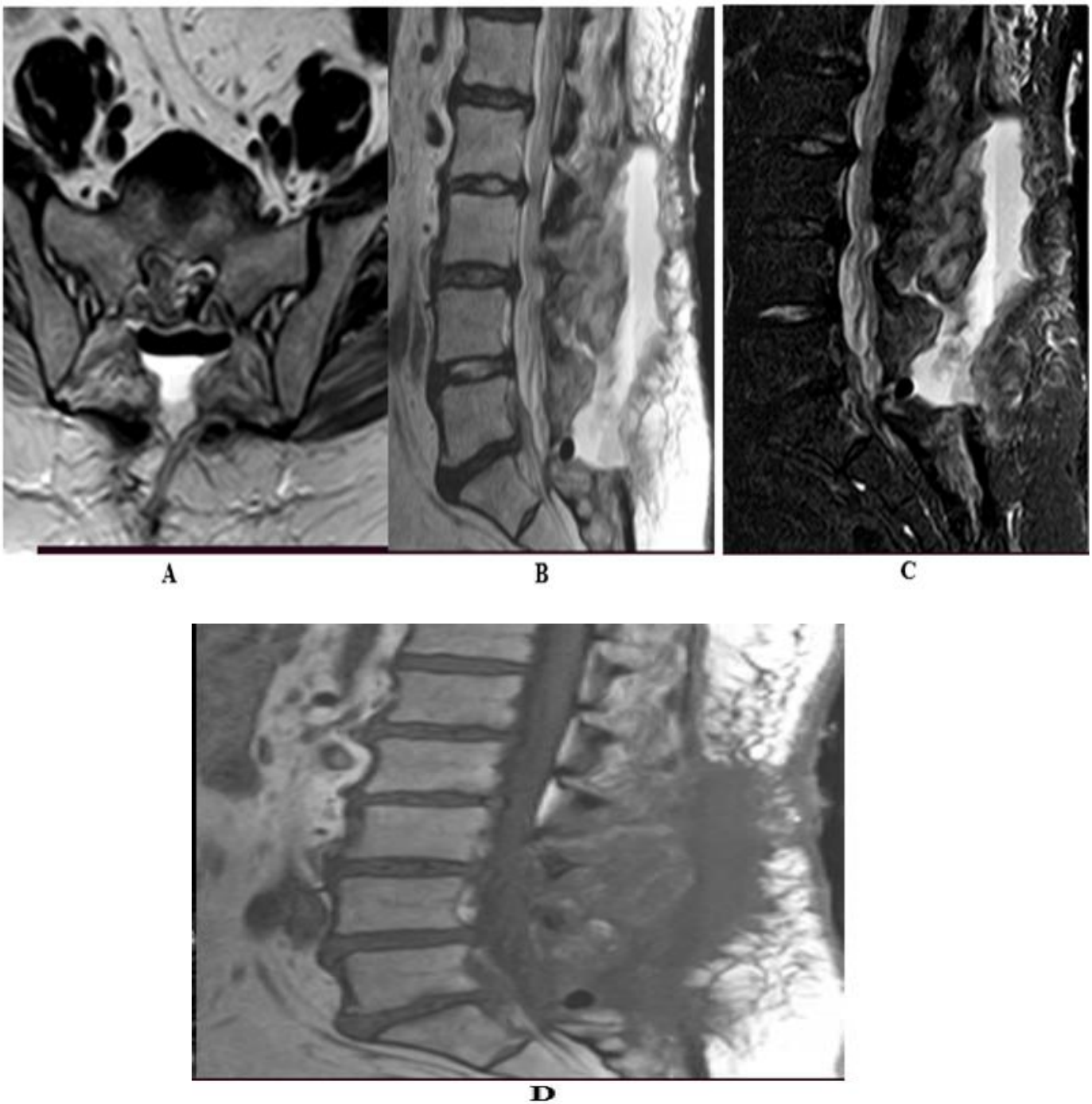


Fig 5. (A) axial and (B) Sagittal T2WI lumbar MRI images, (C) STIR MRI image showing large operative bed hyperintense signal of fluid intensity (localized collection). (D)T1WI image showing hypointense signal of the lesion.

Case (6)

A 28-year-old female patient with a history of disc herniations, underwent L4–L5 and L5–S1 spinolaminectomy three months ago. She now presents with lower back pain and bilateral sciatica. MRI of lumber spine shows diffuse edema and high signal intensity on T2 and STIR sequences involving the paraspinal muscles from L4 to S1, with small linear and branching tract-like fluid collections oriented anteroposteriorly. A sinus tract is noted, with the superior extension terminating in a localized epidural collection at the L3–L4 level measuring approximately 17 × 12 × 12 mm. Aspiration from collection revealed pus.

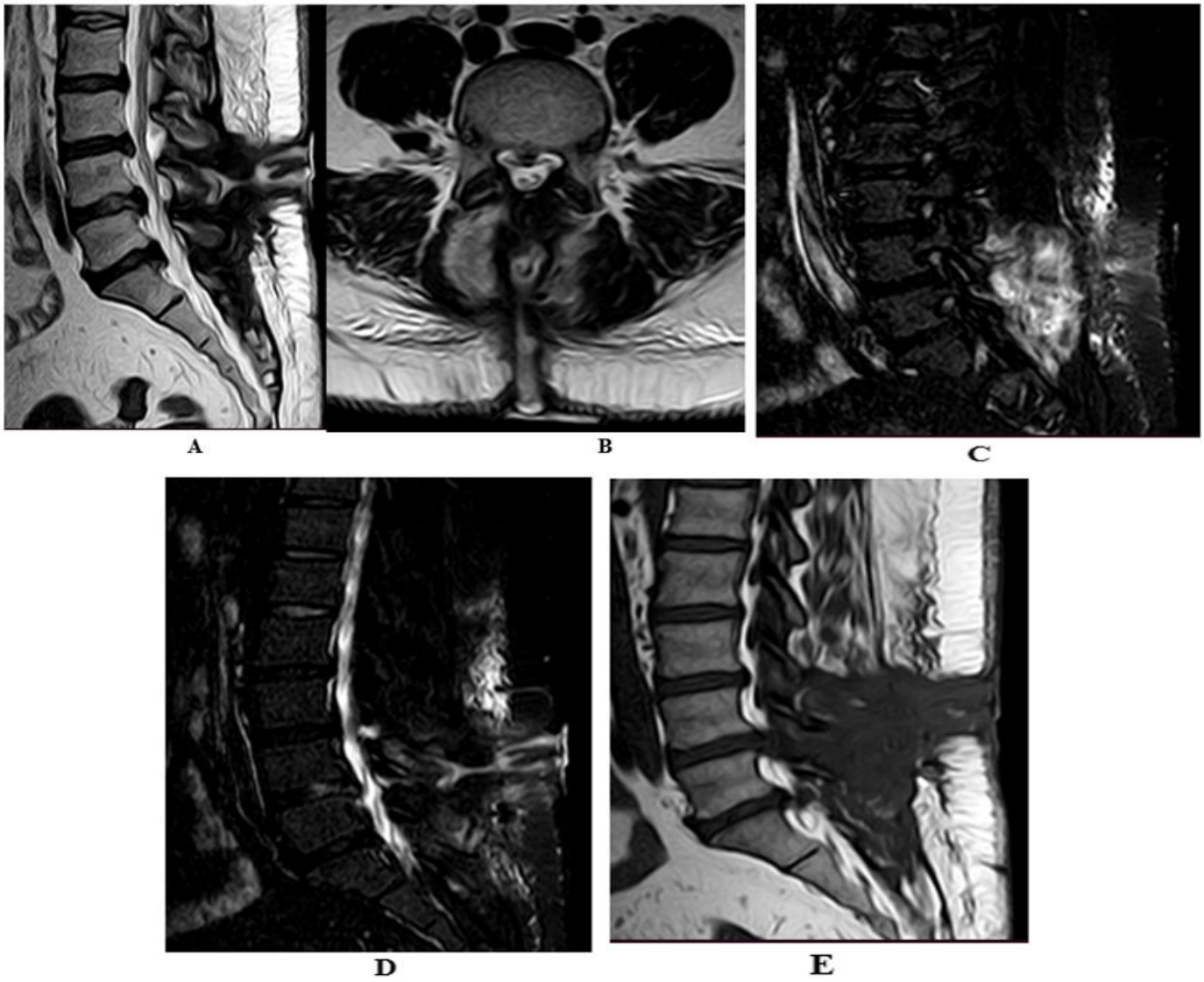


Fig 6. (A) sagittal and (B) axialT2WI lumbar spine MRI images, (C) and (D) STIR images show operative bed branching localized collections surrounded by tissue edema with sinus tract. The lesion exhibit hyperintense signal, (E)T1WI image show operative bed area of low signal intensity.

Discussion

Our study included patients with a mean age in the late forties. The majority were males (68%), while females formed a smaller proportion. Most patients lived in urban areas, while a smaller number came from rural regions.

The age pattern in our study is clearly similar to several published works. A cohort of 50 patients reported a mean age of 49 years (**Masopust et al., 2021**), and another study of 181 patients reported a mean age of 47 years (**Waguespack et al., 2002**), both closely matching our late-forties average. In contrast, younger cohorts with mean ages of 41.0–41.6 years (**Khan et al., 2025**) and older cohorts with a mean of 55.2 years (**Dhatt et al., 2026**) show clear disagreement. This variation is mainly due to different disease groups studied, with degenerative deformities shifting age higher and disc-related or post-surgical populations shifting it lower, meaning our study sits in the middle and partially agrees with both trends.

In terms of gender, our male predominance (68%) is strongly supported by multiple studies. Similar male rates were reported as 70% in 40 patients (**Hemat and El-Adawy, 2014**), 76% in 30 patients (**Dhagat et al., 2017**), and 71.7% in 1,842 patients (**Inoue et al., 2017**), all supporting our finding. However, this is clearly different from a study of 26 patients showing female predominance at 53.8% (**Singh et al., 2026**). This disagreement is explained by disease differences, as female patients may have more osteoporosis-related spinal degeneration (**Mahmood et al., 2025**), which can shift gender patterns in some cohorts.

Regarding residence, our finding of mostly urban patients agrees with a study of 100 patients showing 66% urban residence (**Shawky Abdelgawaad et al., 2024**). However, other literature clearly disagrees that residence itself is important, showing no major difference between rural and urban populations (**Mahmood et al., 2025; Esposito, 2023**). This means our result is likely explained not by location itself, but by occupation and lifestyle factors affecting spine loading.

Clinically, our finding that low back pain was the most common symptom is strongly supported by the literature. One another reported up to 94% baseline low back pain in FBSS patients (**Inoue et al., 2017**), which strongly agrees with our findings.

Fever was present in 50% of our patients. This clearly agrees with infection-based studies showing fever in 66% of spinal epidural abscess cases (**Reihsaus et al., 2000**) and near-universal fever in postoperative spondylodiscitis (**Krishnan et al., 2023**). However, this sharply disagrees with general FBSS populations, where fever rates are much lower, usually 10%–40% (**Orhurhu et al., 2023; Sebaaly et al., 2018**) and around 20% in large surveys (**Inoue et al., 2017**). This confirms that our cohort is more infection-dominant rather than degenerative.

Paraplegia in our study is a severe finding and agrees with rare but serious complications described in epidural abscess cases (**Araújo et al., 2012**). However, it clearly disagrees with general postoperative spine literature, where such severe deficits are very rare (**Barrett et al., 2021**) and usually limited to milder neurological deficits unless there is extensive infection or hematoma (**de Leeuw et al., 2018**).

Surgically, laminectomy was the most common procedure, followed by transpedicular fixation. This agrees with large studies showing decompression in 70.2% and fixation in 22.4% (**Inoue et al., 2017**) and 69% laminectomy usage (**Alobaidi et al., 2021**). However, this clearly differs from studies where posterior fusion is most common at 30% (**Dhatt et al., 2026**). This difference reflects case selection, with our cohort mainly showing compressive stenotic disease rather than instability or deformity.

Operative time in our study matches closely with a mean of 118 ± 28 minutes reported in similar decompression surgeries (**Dalton et al., 2022**). In contrast, much longer times of 185 ± 35 and 173 ± 39 minutes (**Patel et al., 2020**) are reported in fusion-heavy populations, clearly showing procedural differences.

Intraoperative findings showed seroma as the most common lesion (58%), which agrees with literature describing seroma as the most frequent postoperative fluid collection (**Kaur et al., 2025; Malhotra et al., 2015**). However, abscess (48%) and spondylodiscitis (28%) are extremely high compared to standard reported rates of 0.21%–3.6% in discectomy and up to 8.5% in fusion cases (**Gerometta et al., 2012; Di Martino et al., 2019**). This strongly disagrees with general spine literature and clearly shows our cohort is heavily biased toward infectious complications. This is supported by infection-focused studies reporting abscess in up to 68% of cases (**Abouzeid and Niazy, 2019**).

Mechanical complications were less common in our study. Recurrent disc herniation was only 6%, which is lower than the commonly reported 5%–25% range (**Mariscal et al., 2022; Shepard & Cho, 2019**). Spinal stenosis was seen in 20%, which agrees with reports of 20%–29% in revision cohorts (**Kayaoglu et al., 2003**). Arachnoiditis was seen in 10%, which is slightly higher than the 3.5%–7% reported in literature (**Ozgen et al., 1999; Dhagat et al., 2017**), likely due to the high infection burden in our patients (**Paolini et al., 2017**).

On MRI, seroma was again the most common finding (48%), which agrees with radiological literature (**Kaur et al., 2025**). However, abscess (46%) and discitis (28%) are much higher than standard rates of 0.21%–3.6% and about 7% in FBSS populations (**Gerometta et al., 2012; Dhagat et al., 2017**). This strongly disagrees with general literature and again confirms an infection-heavy cohort (**Abouzeid and Niazy, 2019**). Recurrent disc herniation on MRI was only 6%, which is much lower than 45% (**Hemat and El-Adawy, 2014**), 53% (**Dhagat et al., 2017**), and 78% (**Ozgen et al., 1999**), clearly showing a shift away from mechanical pathology. Spinal stenosis (18%) agrees with 20%–29% ranges (**Waguespack et al., 2002**). Arachnoiditis (12%) is slightly higher than 3.5%–7% (**Ozgen et al., 1999; Dhagat et al., 2017**) due to infection-related causes (**Paolini et al., 2017**).

Diagnostic performance of MRI in our study was very high for most conditions. We achieved 100% accuracy for recurrent disc herniation, which agrees with early reports of perfect accuracy in

selected cases (**Fan et al., 1995**), but exceeds larger studies showing lower sensitivity (86%) and accuracy (~90%) (**Mullin et al., 2000**). For spondylodiscitis, our 100% accuracy is higher than reported sensitivity of 93%–96% and specificity of 93%–97% (**Crombé et al., 2024**) and also higher than 71% sensitivity in some settings (**Paez et al., 2021**), likely due to clearer postoperative infection cases in our cohort.

For spinal stenosis, our sensitivity of 90% agrees with 81%–97% ranges (**Kent et al., 1992**) but differs from lower reported values of 75% sensitivity and 77% specificity (**Wassenaar et al., 2012**) due to the dynamic nature of stenosis. For epidural abscess, our results (95.83% sensitivity and 100% specificity) strongly agree with MRI being the gold standard (**Tetsuka et al., 2020**).

For arachnoiditis, sensitivity was low at 60%, which disagrees with reported 92% sensitivity and 100% specificity (**Sen and Singh, 1999**), likely because our cases were early or mild rather than advanced disease. Seroma detection sensitivity was 82.76%, which is consistent with known MRI limitations in differentiating sterile fluid from early infection (**Kaur et al., 2025**).

This study has some limitations. It was conducted on a small, single-center sample, which may limit the generalizability of the results. Its cross-sectional design also prevented long-term follow-up and assessment of prognostic outcomes. Variations in surgical procedures and postoperative timing may have influenced MRI findings. In some cases, metallic implants caused imaging artifacts despite reduction techniques. Additionally, not all MRI-detected abnormalities were confirmed surgically, which may have affected diagnostic accuracy assessment, particularly for arachnoiditis.

Concussion

MRI is a highly reliable and effective tool for evaluating postoperative lumbar spine complications due to its superior soft tissue contrast and strong diagnostic accuracy. It shows excellent performance in detecting recurrent disc herniation, spondylodiscitis, spinal stenosis, abscesses, and seroma, with high sensitivity and specificity across most conditions. Although its accuracy is comparatively lower for arachnoiditis, it remains clinically useful overall. Thus, MRI is essential for early detection, precise diagnosis, and timely management of postoperative lumbar spine complications, supporting better clinical outcomes and guiding appropriate treatment decisions.

References

- **Abouzeid WK**, & **Niazy T**. (**2019**). Surgical treatment of spondylodiscitis: clinical and surgical outcome of a double-centered experience. Minia Journal of Medical Research, 30(2): 280-288.
- **Alobaidi AI**, **Saeed MAM**, & **Hamdan TA**. (**2021**). Pattern of serial inflammatory biomarkers changes in post lumbar discectomy patients in Basrah, Iraq. Rawal Medical Journal, 46(3): 564-564.
- **Araújo F**, **Ribeiro C**, **Silva I**, **Nero P**, & **Branco J**. (**2012**). Klebsiella pneumoniae spinal epidural abscess treated conservatively: case report and review. Acta reumatologica portuguesa, 37(1): 1-4.
- **Barrett KK**, **Fukunaga D**, & **Rolfe KW**. (**2021**). Perioperative major neurologic deficits as a complication of spine surgery. Spinal Cord Ser Cases, 7(1): 1-5.
- **Crombé A**, **Fadli D**, **Clinca R**, **Reverchon G**, **Cevolani L**, **Girolami M**, **et al.** (**2024**). Imaging of spondylodiscitis: a comprehensive updated review-multimodality imaging findings, differential diagnosis, and specific microorganisms detection. Microorganisms, 12(5):1-22.
- **Dalton JF**, **Oyekan A**, **Ridolfi D**, **Gannon E**, **Ruh E**, **Sharma V**, et al. (**2022**). Minimally invasive transforaminal lumbar interbody fusion with enhanced recovery after surgery (ERAS): early experience with initial consecutive cases at a spine naïve community hospital. J Minim Invasive Spine Surg Tech, 7(2): 259-265.
- **de Leeuw CN**, **Fann PR**, **Tanenbaum JE**, **Buchholz AL**, **Freedman BA**, **Steinmetz MP**, et al. (**2018**). Lumbar epidural abscesses: a systematic review. Global Spine J, 8(4 Suppl): 85s-95s.
- **Dhagat PK**, **Jain M**, **Singh SN**, **Arora S**, & **Leelakanth K**. (**2017**). Failed back surgery syndrome: evaluation with magnetic resonance imaging. J Clin Diagn Res, 11(5): Tc06-tc09.
- **Dhatt SS**, **Gupta A**, **Kumar V**, **Das S**, & **Dunga ST**. (**2026**). Clinical insights and statistical analysis of failed back surgery syndrome: a multicentric retrospective review. Asian Journal of Neurosurgery, 21(01): 078-086.
- **Di Martino A**, **Papalia R**, **Albo E**, **Diaz L**, **Denaro L**, & **Denaro V**. (**2019**). Infection after spinal surgery and procedures. European Review

for Medical and Pharmacological Sciences, 23(2): 173-178.
- **Esposito DU**. (**2023**). MRI-based grading systems for assessing lumbar disc degeneration. Macquarie University, 1-183.
- **Fan YF**, **Chong VFH**, & **Tan SK**. (**1995**). Failed back surgery syndrome: differentiating epidural fibrosis and recurrent disc prolapse with Gd-DTPA enhanced MRI. Singapore Medical Journal, 36(1): 153-156.
- **Gerometta A**, **Bittan F**, & **Rodriguez Olaverri JC**. (**2012**). Postoperative spondilodiscitis. International Orthopaedics, 36(2): 433-438.
- **Girão MMV**, **Miyahara LK**, **Dwan VSY**, **Baptista E**, **Taneja AK**, **Gotfryd A**, et al. (**2023**). Imaging features of the postoperative spine: a guide to basic understanding of spine surgical procedures. Insights into Imaging, 14(1): 1-10.
- **Hemat E**, & **El-Adawy A**. (**2014**). Failed back surgery syndrome: magnetic resonance imaging assessment. Advanced Spine Journal, 11(1): 11-17.
- **Inoue S**, **Kamiya M**, **Nishihara M**, **Arai YP**, **Ikemoto T**, & **Ushida T**. (**2017**). Prevalence, characteristics, and burden of failed back surgery syndrome: the influence of various residual symptoms on patient satisfaction and quality of life as assessed by a nationwide internet survey in Japan. J Pain Res, 10(1): 811-823.
- **Kaur S**, **Lalam R**, & **Trivedi R**. (**2025**). Imaging of the postoperative spine. RöFo-Fortschritte auf dem Gebiet der Röntgenstrahlen und der bildgebenden Verfahren, 1(1):1-16.
- **Kayaoglu CR**, **Calikoğlu C**, & **Binler S**. (**2003**). Re-operation after lumbar disc surgery: results in 85 cases. J Int Med Res, 31(4): 318-323.
- **Kent DL**, **Haynor DR**, **Larson EB**, & **Deyo RA**. (**1992**). Diagnosis of lumbar spinal stenosis in adults: a metaanalysis of the accuracy of CT, MR, and myelography. Am J Roentgenol, 158(5): 1135-1144.
- **Khan A**, **Haq M**, & **Noman M**. (**2025**). Frequency of post-operative back pain in patients with laminectomy. Insights-Journal of Health and Rehabilitation, 3(1): 817-825.
- **Krishnan A**, **Chauhan V**, **Degulmadi D**, **Mayi S**, **Rai RR**, **Dave M**, et al. (**2023**). Postoperative lumbar spondylodiscitis following transforaminal endoscopy and outcomes of transforaminal lumbar interbody fusion. J Minim Invasive Spine Surg Tech, 8(1): S39-50.
- **Mahmood AS**, **Naif MM**, & **Alkhayat AA**. (**2025**). Neurological findings and magnetic resonance imaging in patients with low back pain in Ninevah province.
- **Malhotra A**, **Kalra V**, **Wu X**, **Grant R**, **Bronen R**, & **Abbed K**. (**2015**). Imaging of lumbar spinal surgery complications. Insights into Imaging, 6(1):1-12.
- **Mariscal G**, **Torres E**, & **Barrios C**. (**2022**). Incidence of recurrent lumbar disc herniation: a narrative review. J Craniovertebr Junction Spine, 13(2): 110-113.
- **Masopust V**, **Holubová J**, **Skalický P**, **Rokyta R**, **Fricová J**, **Lacman J**, et al. (**2021**). Neuromodulation in the treatment of postoperative epidural fibrosis: comparison of the extent of epidural fibrosis and the effect of stimulation. Physiol Res, 70(3): 461-468.
- **Mullin WJ**, **Heithoff KB**, **Gilbert TJ Jr**, & **Renfrew DL**. (**2000**). Magnetic resonance evaluation of recurrent disc herniation: is gadolinium necessary? Spine (Phila Pa 1976), 25(12): 1493-1499.
- **Orhurhu VJ**, **Chu R**, & **Gill J**. (**2023**). Failed back surgery syndrome. StatPearls [Internet].
- **Ozgen S**, **Naderi S**, **Ozek MM**, & **Pamir MN**. (**1999**). Findings and outcome of revision lumbar disc surgery. J Spinal Disord, 12(4): 287-292.
- **Paez D**, **Sathekge MM**, **Douis H**, **Giammarile F**, **Fatima S**, **Dhal A**, et al. (**2021**). Comparison of MRI, [(18)F]FDG PET/CT, and (99m)Tc-UBI 29-41 scintigraphy for postoperative spondylodiscitis-a prospective multicenter study. Eur J Nucl Med Mol Imaging, 48(6): 1864-1875.
- **Paolini CP**, **Prieto MR**, **Vazquez AB**, **Rosales KR**, **Hidalgo LH**, & **de Vega VM**. (**2017**). Failed back surgery syndrome (FBSS): what does the surgeon want to know?. ESR, 1(1):1-5.
- **Park JH**, **Kim DH**, **Chai JW**, **Kim HJ**, **Seo J**, & **Son JY**. (**2024**). Imaging evaluation of early and long-term complications associated with the postoperative spine. J Korean Soc Radiol, 85(1): 36-18.
- **Patel J**, **Kundnani V**, **Kuriya S**, **Raut S**, & **Meena M**. (**2020**). Surgical outcomes of minimally invasive transforaminal lumbar interbody fusion in elderly. J Minim Invasive Spine Surg Tech, 5(1): 13-19.
- **Reihsaus E**, **Waldbaur H**, & **Seeling W**. (**2000**). Spinal epidural abscess: a meta-analysis of 915 patients. Neurosurg Rev, 23(4): 175-204.

- **Sakaguchi T**, **Gunjotikar S**, **Tanaka M**, **Komatsubara T**, **Latka K**, **Ekade SJ**, et al. (**2024**). Evaluation and rehabilitation after adult lumbar spine surgery. J Clin Med, 13(10): 1-23.
- **Sebaaly A**, **Lahoud MJ**, **Rizkallah M**, **Kreichati G**, & **Kharrat K**. (**2018**). Etiology, evaluation, and treatment of failed back surgery syndrome. Asian Spine J, 12(3): 574-585.
- **Sen KK**, & **Singh A**. (**1999**). Magnetic resonance imaging in failed back surgery syndrome. Med J Armed Forces India, 55(2): 133-138.
- **Shawky A A**, **El-Sharkawi M**, **Sarhan AM**, **Hassanien MA**, & **Aziz M**. (**2024**). Validation of the Arabic version of the EuroQol-5-dimension 5-level (EQ-5D-5 L) in patients with spinal degenerative diseases. BMC Public Health, 24(1): 1119.
- **Shepard N**, & **Cho W**. (**2019**). Recurrent lumbar disc herniation: a review. Global Spine Journal, 9(2): 202-209.
- **Singh J**, **Mishra VK**, **Garg H**, & **Tyagi H**. (**2026**). The etiology and treatment of failed back surgery syndrome in patients with primary lumbar fixation. J Orthop Case Rep, 16(5): 314.
- **Tetsuka S**, **Suzuki T**, **Ogawa T**, **Hashimoto R**, & **Kato H**. (**2020**). Spinal epidural abscess: a review highlighting early diagnosis and management. JMA J, 3(1): 29-40.
- **Waguespack A**, **Schofferman J**, **Slosar P**, & **Reynolds J**. (**2002**). Etiology of long-term failures of lumbar spine surgery. Pain Med, 3(1): 18-22.
- **Wassenaar M**, **van Rijn RM**, **van Tulder MW**, **Verhagen AP**, **van der Windt DA**, **Koes BW**, **et al.** (**2012**). Magnetic resonance imaging for diagnosing lumbar spinal pathology in adult patients with low back pain or sciatica: a diagnostic systematic review. Eur Spine J, 21(2): 220-227.