

Indication Based MR Imaging: Impact on Diagnosis and Patient Management

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ABSTRACT

Indication-based MRI is essential to maximizing diagnostic yield and enabling expedited patient management in an evidence-driven fashion according to presenting symptoms. This is a series of five challenging cases in which conventional MRI protocols did not reveal underlying disease, and evidence-based patient history- and symptom-directed targeted sequences were employed as a requisite modification. Through the use of specialized sequences—like Trufi sequences in renal obstruction, 3D STIR for nerve compression, and high-resolution optic nerve imaging—clinically significant diagnoses were resolved, culminating in appropriate treatment and better outcomes. In one instance, a patient with intractable swelling and urinary retention presented with no findings on normal cervical MRI, but whole-spine Trufi sequence demonstrated hydroureteronephrosis, directing emergent intervention. Another example showed how 3D STIR imaging revealed lumbar plexus compression not visible on routine lumbar MRI, in accordance with the patient's radicular pain. Likewise, the inclusion of the sacroiliac joints in a patient with normal lumbar findings showed sacroiliitis, and optic nerve sequences revealed inflammation in a patient presenting with visual symptoms. CSF leaks postoperatively were also localized correctly using high-field 3D STIR thin sequences, enabling early surgical repair. These cases demonstrate the limitations of routine imaging when clinical syndromes imply more diffuse or insidious pathologies. Indication-based MRI not only avoids unnecessary repeat scans—patient and cost savings—but also increases confidence in diagnosis, enabling early and effective treatment. For clinicians, it provides clarity in challenging cases, and hospitals gain from improved resource allocation. Finally, this strategy highlights the need for personalized imaging protocols that address the specific requirements of each patient, with improved diagnostic precision and therapeutic results. By making symptom-guided MRI adaptations a priority, healthcare organizations can provide more tailored and effective care.

Keywords: Clinical indications, indication-based MRI, specialized MRI sequences (e.g., Trufi, 3D STIR), tailored imaging sequences.

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1. INTRODUCTION

Indication-based magnetic resonance imaging (MRI) has emerged as a pivotal tool in enhancing diagnostic accuracy and patient management across various medical conditions. By tailoring imaging sequences to specific clinical presentations, radiologists can uncover underlying pathologies that might otherwise go unnoticed, thereby facilitating timely and appropriate interventions.

Indication-based imaging involves selecting the appropriate imaging techniques and sequences according to specific clinical indications, taking into account the

patient's medical history, symptoms, and results from physical examinations. This process considers the clinician's recommended imaging approach, along with the provisional or differential diagnoses and the patient's unique clinical characteristics. By evaluating how these clinical features align with the suggested imaging study, adjustments can be made if necessary. Any modifications or extensions to the imaging study are discussed with the clinician to ensure that both the patient's and clinician's needs are effectively met.



Customizing imaging studies for patients offers numerous advantages. It minimizes the need for repeated tests, which can lower healthcare costs, reduce wait times, alleviate patient anxiety, and decrease radiation exposure. Furthermore, cutting down on redundant testing helps hospitals use their resources and manpower more efficiently, allowing them to serve more patients within the same timeframe.

From the perspective of clinicians, indication-based imaging is essential for making quick and accurate diagnoses, enabling them to effectively identify and characterize various diseases and conditions. By selecting the appropriate imaging techniques, healthcare providers can develop timely and targeted treatment plans, ultimately leading to better patient outcomes.

In this report, we present several cases where indication-based imaging was successfully implemented, demonstrating these benefits in practice. These case studies illustrate the significant impact of indication-based MRI on diagnosis and treatment outcomes in diverse clinical scenarios. Each case highlights how a focused approach to imaging not only clarified ambiguous clinical presentations but also guided management decisions, ultimately leading to improved patient outcomes.

The value of indication-based MR Imaging is in its ability to improve diagnostic precision, better inform treatment strategies, and ultimately enhance patient care. By fostering a more nuanced understanding of the patient's condition, indication-based imaging plays an essential role in contemporary radiological practice.

2. OBJECTIVES

2.1. General Objective

The primary objective of this case series is to assess the impact of indication-based magnetic resonance (MR) imaging on improving diagnostic accuracy and patient management in complex cases with varied symptoms that require precise imaging for diagnosis.

2.2. Specific Objectives

1. To highlight the role of MR imaging tailored to patient symptoms and clinical indications in revealing critical findings that may not be visible in routine sequences.
2. To evaluate how indication-based imaging aids in identifying non-spinal conditions, such as renal obstructions and optic nerve inflammations, which influence patient treatment plans.
3. To demonstrate the effectiveness of specialized sequences, like Trufi or 3D STIR, in confirming diagnoses and guiding pre-surgical planning, leading to better patient outcomes.
4. To examine how extending routine MR imaging beyond initial focus areas, such as sacroiliac joints or optic nerves, can lead to early and accurate diagnosis of underlying conditions missed by conventional imaging.
5. To assess the positive impact of imaging-guided treatment adjustments on symptom relief and long-term patient recovery.

3. METHODOLOGY

This case series explores the impact of indication-based MRI protocols on diagnostic accuracy and patient management. Five cases were selected where indication-specific imaging approaches led to refined diagnosis and targeted treatment outcomes. For each case, a standard MR imaging protocol was first conducted, followed by additional, targeted sequences based on clinical symptoms and preliminary findings.

3.1. Patient Selection

Patients with varying complaints, including back pain, neck pain, limb pain, visual disturbances, and postoperative complications, were referred for MRI based on clinical presentations requiring further diagnostic clarity.

3.2. Imaging Protocols

Routine MRIs were performed initially with standard T1-weighted, T2-weighted, Short Tau Inversion Recovery (STIR), and myelogram sequences for the targeted body regions (cervical or lumbar spine, brain). Based on each case's unique clinical features, additional sequences were subsequently performed:

- *Trufi Coronal sequence* for lumbar assessment in cases showing signs of potential renal involvement.
- *3D STIR and MIP* sequences for nerve compression evaluation.
- *Thin-slice, pre- and post-contrast images* for optic nerve evaluation in a case involving visual symptoms.
- *3D STIR thin sequence* for identifying CSF leakage in postoperative cases.

3.3. Decision-Making

Additional sequences were selected upon careful consideration of initial imaging findings and alignment with patients' symptomatic patterns. Permission was taken from the patient party to contact the referring physician after explaining the clinical scenario and preliminary findings. Collaboration with referring specialists allowed for tailored MRI protocol adjustments based on the clinical needs of the patient and specialist. Informed consent was taken from the patient party again before starting any extended protocol.

3.4. Follow-Up and Outcome Evaluation

Each patient's symptoms and clinical outcomes were monitored post-imaging to evaluate the effectiveness of diagnosis-based treatment plans. Detailed follow-ups confirmed symptom resolution, targeted surgical interventions, and referral for specialized care, demonstrating the significance of indication-based imaging in improving patient management.

This methodological approach, centered on patient-specific imaging, allowed for a comprehensive diagnostic assessment that directly influenced treatment adjustments, surgical planning, and patient referrals to specialists when necessary.

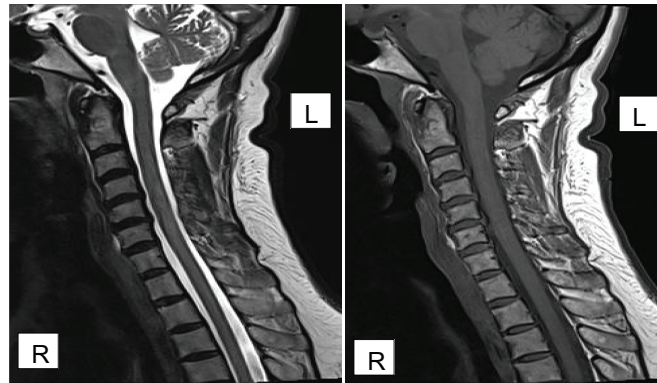


Fig. 1. Routine Protocol: T2W TSE and T1W TSE Sagittal Images Shows degenerative changes and disc desiccation.

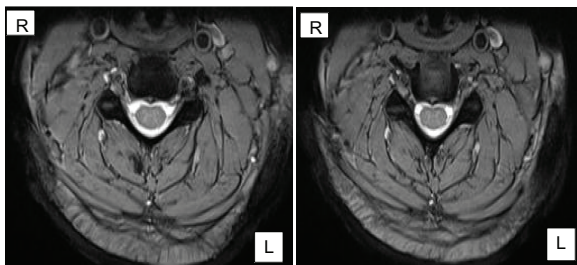


Fig. 2. Routine Protocol: T2W Transverse Images of C4-5 vertebra level. Shows no nerve root compression or cord compression.

4. RESULTS

4.1. Case 1

A 51-year-old woman presented with persistent back and neck pain, neck stiffness, and generalized swelling throughout her body, which had been ongoing for over a year. She had been referred for an MRI of the cervical spine, along with a whole spine screening. There was no radiation of pain and no history of trauma. Upon further questioning, she also reported long-term low back pain, particularly in the lumbar region, along with incomplete urination and recurrent swelling.

Figs. 1–3 present an MRI of the cervical spine was conducted using T1-weighted, T2-weighted, and STIR sagittal sequences, along with T1W and T2W transverse views, STIR coronal, and a 2D myelogram sequence. The findings indicated osteoarthritis and disc desiccation at the C4-5 level, but no disc bulge or herniation was detected.

However, during the whole spine screening, irregularities were noted in the left lumbar region. Given her history of bilateral loin pain and urinary symptoms, it was suspected that the renal system might be involved. After discussion with the referring specialist, a coronal Trufi sequence of the lumbar region was added to the imaging study [1]. This sequence revealed significant left-sided hydroureteronephrosis due to an obstruction in the left mid-ureter [2].

4.1.1. Follow up

The patient was initially treated for osteoarthritis and referred to a nephrologist by their primary care physician. After receiving the necessary treatment, they experienced a gradual improvement in all symptoms. As of now, the

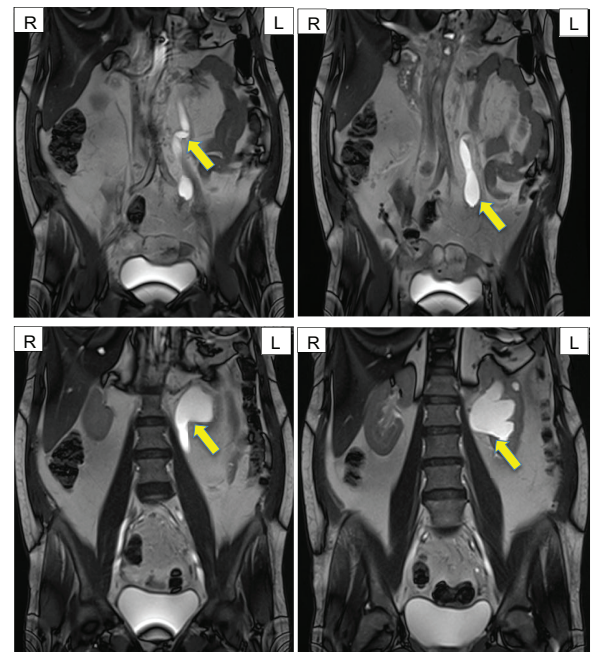


Fig. 3. Indication based protocol: Trufi Coronal Images: left-sided hydroureteronephrosis. Dilated RT renal pelvicalyceal system and RT ureter.

patient reports no swelling, neck stiffness, or back pain, and their urinary function has fully returned to normal.

4.2. Case 2

A 57-year-old female patient presented to the radiology department for an MRI of the lumbar spine. She had been admitted to another hospital with severe low back pain, primarily on the left side, along with significant tenderness and difficulty moving for the past few days. Additionally, she reported intermittent groin and thigh pain that had been ongoing for the last two months. The referring physician suspected lumbar disc disease or lumbar radiculopathy, with a possible left hip arthropathy.

During the MRI preparation and positioning, it was observed that the patient experienced severe tenderness in the left lumbar region, which radiated to the inguinal area and down to her thigh. Her movement was notably restricted due to the intense pain.

A routine MRI of the lumbosacral spine was initially performed, including T1-weighted, T2-weighted, and STIR sagittal sequences, T2-weighted and T1-weighted

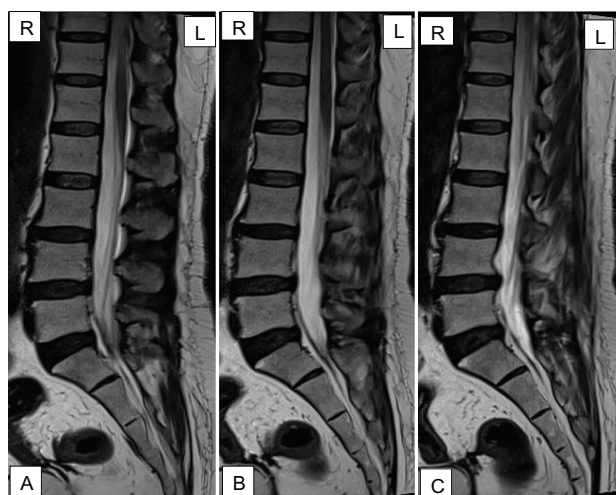


Fig. 4. Routine Protocol: T2 TSE Sagittal Images.

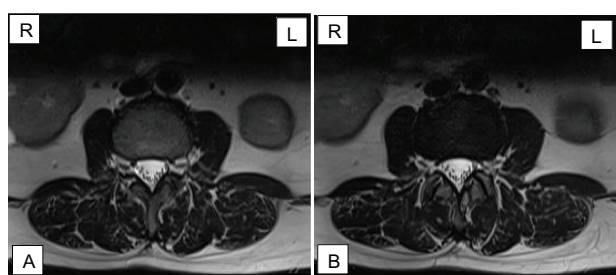


Fig. 5. Routine Protocol: T2W TSE Transverse Images of L3-4 vertebrae level.

transverse sequences, STIR coronal views, and 2D myelogram sequences Fig. 6. The MRI revealed disc bulging with anterior indentation of the thecal sac and neural foraminal narrowing, causing mild compression of the nerve roots at the L3-4 and L4-5 levels on both sides. At the L5-S1 level, there was a central disc bulge [3].

Given the patient's left-sided inguinal and thigh pain radiating from the lumbar region, a 3D STIR [4] sequence of the lumbar spine was added. The MIP images from the 3D STIR sequence showed compression and inflammation of the proximal L3 lumbar plexus [5] extending into the left inguinal region

Figs. 4A–4C and 5A, 5B shows nerve roots compression at L3-4 and L4-5 levels on both sides. Central disc bulge at L5-S1 level.

4.2.1. Follow up

The patient continued regular follow-ups with the orthopedic specialist who referred them. Based on the imaging results, the treatment plan was modified to include anti-inflammatory therapy. As of now, the patient is free from pain.

4.3. Case 3

A 54-year-old male patient presented to the radiology department for an MRI of lumbosacral spine due to a history of low back pain radiating to his right buttock. He also reported discomfort in the sacroiliac region, which worsened with movement. Notably, he had no history of sciatica or trauma. Previous X-rays of the lumbosacral spine indicated mild sacroiliitis on the left side (opposite

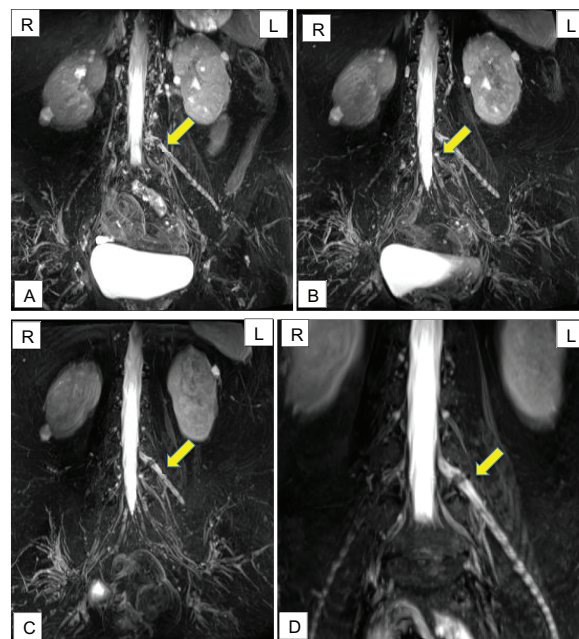


Fig. 6. A, B, C & D Indication based protocol: 3D STIR MIP Images of Lumbar plexus showing left sided inflammatory change. Inflammatory changes at proximal L3 Plexus.

the site of his complaint) and a reduction in the height of the L2 vertebra.

A routine MRI of the lumbosacral spine was performed, including T1-weighted, T2-weighted, and STIR sagittal sequences, as well as T2-weighted and T1-weighted transverse sequences, STIR coronal sequences, and 2D myelogram imaging Fig. 7. The MRI revealed diffuse disc bulging with mild central disc protrusions at the L3-4, L4-5, and L5-S1 levels, along with bilateral mild neural foraminal narrowing.

However, since the imaging results did not correlate with the patient's clinical symptoms, it was decided to extend the scan to include both sacroiliac joints in order to assess the cause of sacroiliac pain [7]. The STIR coronal and STIR oblique transverse sequences of the sacroiliac joints revealed hyperintensities in the ala of the sacrum on the right side, implicating sacroiliitis [8] as well as corresponding to the side of the patient's complaints. This finding had been missed in both the initial X-ray and the routine lumbosacral spine MRI.

Figs. 8 and 9 shows STIR coronal and STIR oblique transverse images shows hyperintensities in the ala of the sacrum on the right side, implicating sacroiliitis.

4.3.1. Follow up

The patient returned to the referring physician with the MRI results, which guided a tailored therapy plan based on the imaging findings. As a result, the patient's symptoms improved steadily, and at the time of this report, they are free from pain.

4.4. Case 4

A 50-year-old male patient was referred from a Tertiary Ophthalmology Hospital for an MRI of the brain with contrast due to a one-month history of vertigo, eye pain, and decreased vision in his left eye. He reported no headaches, fever, or trauma.

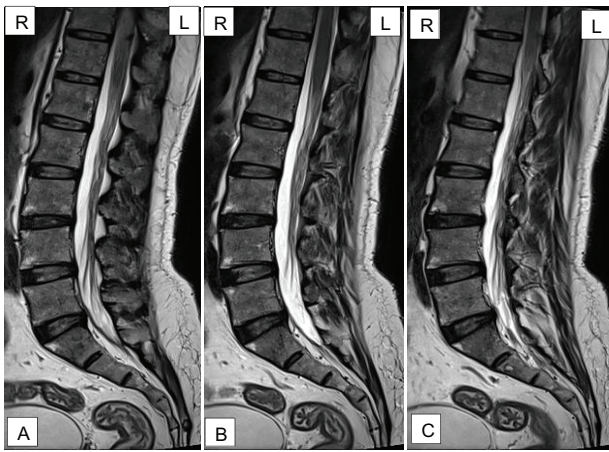


Fig. 7. Routine Protocol: T2W TSE Sagittal Images Disc bulg with central disc protrusions at L3-4, L4-5, and L5-S1 levels, along with bilateral mild neural foraminal narrowing.

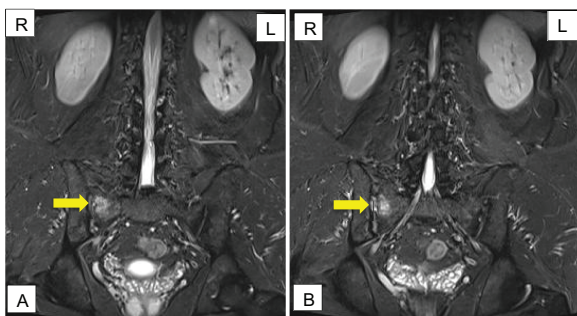


Fig. 8. Indication based protocol: STIR Coronal Images of Lumbosacral region.

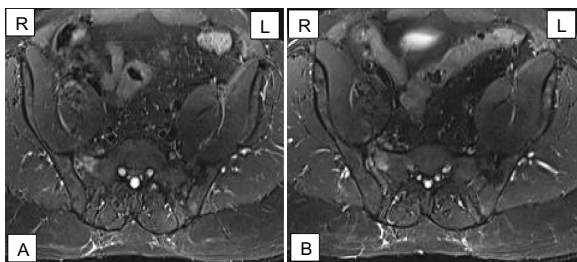


Fig. 9. Indication based protocol: STIR oblique transverse Images of both Sacro-iliac joints.

The initial MRI of the brain was performed, which included transverse T2, T1, DWI, and FLAIR sequences with 5 mm thickness, along with T2-weighted coronal and T1-weighted sagittal images. The MRI results, both with and without contrast, revealed no abnormalities in the brain.

Considering the patient's clinical symptoms, the decision was made to obtain thin-slice sequences of the optic nerve [11] to identify any small or submillimeter lesions that might have been missed in the routine scans. These targeted sequences, which included 2 mm thick transverse and coronal images both pre- and post-contrast, indicated a slightly thickened and heterogeneous left optic nerve [12]. The contrast enhancement pattern was consistent with an inflammatory process.

Figs. 10 and 11 shows no significant abnormality of brain.

Figs. 12 and 13 shows thickened and heterogeneous left optic nerve consistent with an inflammatory process.

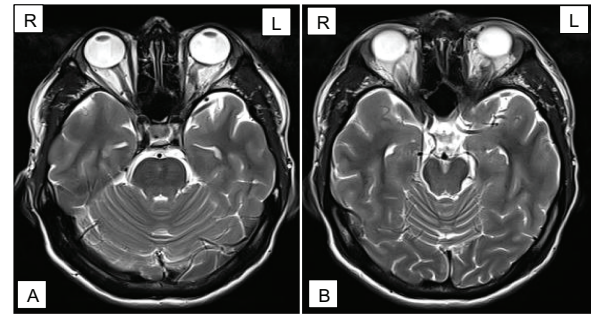


Fig. 10. Routine Protocol: T2W Transverse Images (5 mm thickness).

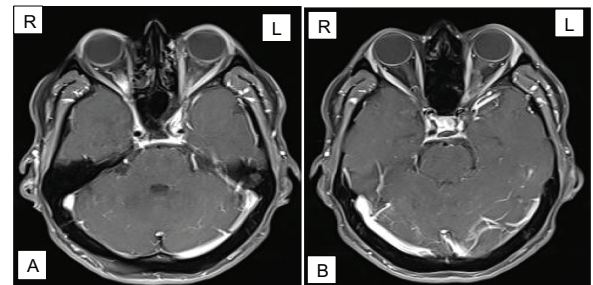


Fig. 11. Routine Protocol: T1W FS Transverse Post Contrast Images (5 mm thickness).

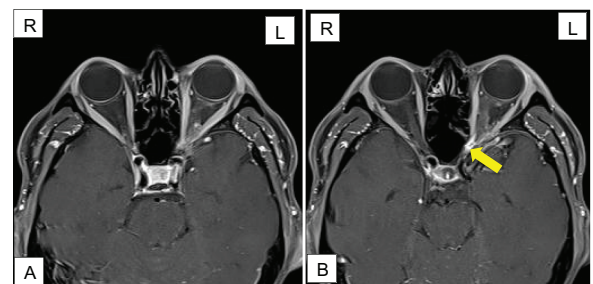


Fig. 12. Indication based protocol: T1W FS Transverse Post Contrast Images (2 mm thickness).

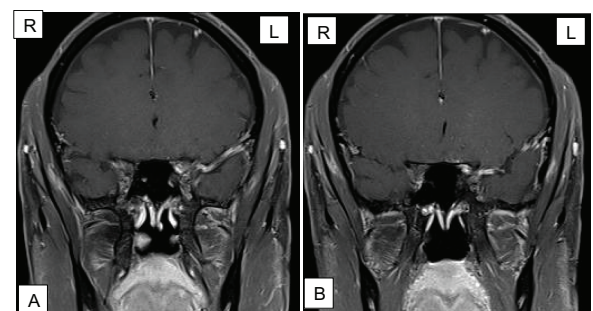


Fig. 13. Indication based protocol: T1W FS Coronal Post Contrast Images (2 mm thickness).

4.4.1. Follow up

The patient visited the designated Ophthalmology Center with an MRI report in hand and was admitted for ten days to receive more comprehensive care. Unfortunately, despite these efforts, he was unable to regain vision in his left eye.

4.5. Case 5

A 65-year-old male patient presented to our radiology department for an MRI of the cervical spine following a decompressive laminectomy for cervical disc herniation.

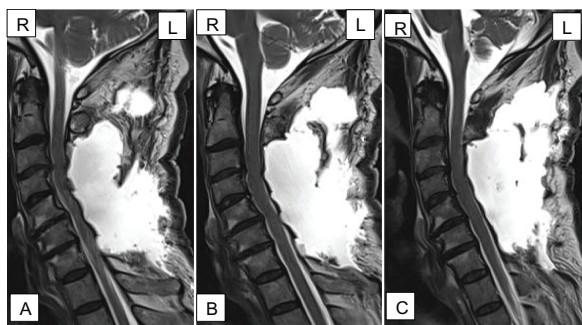


Fig. 14. Routine Protocol: T2W TSE Sagittal Images. Shows CSF signal intensity extending from the C1 to C7 levels at the back of the neck.

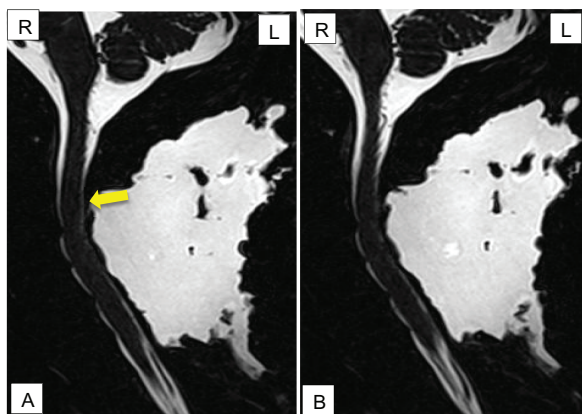


Fig. 15. Indication based protocol: 3D STIR Sagittal Images (1 mm slice thickness).

He had been experiencing neck and back pain for the past two years, with left lower limb pain and numbness developing over the last year. Post-surgery, he reported a worsening swelling at the back of his neck, along with persistent neck pain and stiffness. The referring physician's provisional diagnosis was post-laminectomy cerebrospinal fluid leak [14].

A routine cervical spine MRI was performed, which included T1-weighted, T2-weighted, and STIR sequences in the sagittal view, as well as T1 and T2 in the transverse view, and STIR in the coronal view, along with 2D myelogram sequences Fig. 14. The MRI revealed a significant area of cerebrospinal fluid (CSF) signal intensity [15] extending from the C1 to C7 levels at the back of the neck, corresponding to the bilateral laminectomy wounds from C3 to C7. While the site of the CSF leak was suspected to be at the C6 level on the right side, routine sequences did not definitively confirm this [16].

After consulting with the primary surgeon, it was decided to perform additional imaging to accurately locate the site of the CSF leak prior to any further surgical intervention. A 3D STIR thin-slice sequence was conducted to identify the CSF leakage sinus tract. This advanced sequence successfully showed a sinus tract with CSF leakage at the C3-4 level, which could not be pinpointed with the routine MRI sequences.

Figs. 15 and 16 shows their reveals sinus tract with CSF leakage at the C3-4 level.

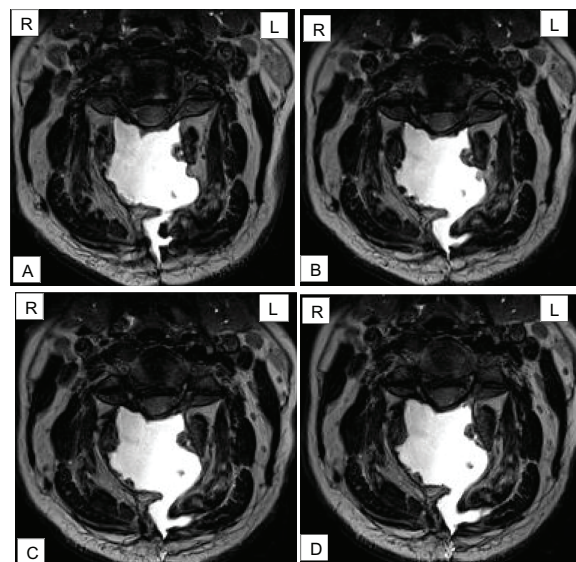


Fig. 16. 3D STIR Transverse Images (1 mm slice thickness).

4.5.1. Follow up

Reconstructive surgery was performed on the same day as the MRI procedure. During the operation, the source of the cerebrospinal fluid (CSF) leak was identified at the C3-4 vertebral level, which corresponded to the findings from the MRI sequences. As of now, there has been no recurrence of neck swelling, and the patient is experiencing no symptoms

5. DISCUSSION

This case series highlights the crucial role of indication-based MRI imaging in improving diagnostic accuracy and guiding patient management across various clinical presentations. In several of the cases presented, routine MRI sequences were insufficient to capture the full scope of the pathology, underscoring the need for individualized imaging approaches based on specific clinical indications.

In Case 1, the routine MRI of the cervical spine did not reveal any significant findings related to the patient's whole-body swelling and incomplete micturition. However, upon performing a whole-spine survey with an additional Trufi sequence, gross hydronephrosis with obstruction [1], [3] was identified. This case demonstrates the value of expanding imaging beyond the initial prescribed region when patient history suggests multi-system involvement.

Case 2 illustrates how indication-based imaging contributed to better management of a patient with severe lumbar pain and suspected lumbar radiculopathy. The routine lumbar spine MRI showed disc pathology, but based on the patient's symptoms, a 3D STIR sequence revealed proximal L3 lumbar plexus compression [6], aligning with the patient's clinical presentation of thigh and groin pain. This case shows how modifying imaging protocols based on symptoms can significantly enhance diagnostic precision and influence treatment [7].

In Case 3, a routine lumbosacral spine MRI did not correlate with the clinical symptoms, but extending imaging to the sacroiliac region revealed hyperintensities in the

right sacral ala indicative of sacroiliitis [9]. This important finding was missed by the initial MRI and X-rays. This highlights the importance of adjusting imaging regions and modalities [10] when clinical symptoms do not align with routine findings, ensuring proper diagnosis and appropriate therapy.

Case 4 emphasizes the need for targeted imaging, where the routine MRI of the brain did not show abnormalities in a patient with eye-related symptoms. When thin-slice imaging of the optic nerve was performed, inflammatory changes [13] in the left optic nerve were revealed. This case underlines the importance of considering clinical features when designing imaging protocols, particularly in cases where subtle pathologies are suspected.

Finally, in Case 5, the identification of a CSF leak following decompressive laminectomy surgery was only possible after performing a 3D STIR thin sequence, which confirmed the site of leakage. The routine MRI sequences were insufficient to pinpoint the leak location, emphasizing the need for advanced imaging techniques [17] in postoperative cases for accurate surgical planning and better patient outcomes.

In all these cases, indication-based imaging has led to the benefit of all parties involved — patients, clinicians and the hospital. For our patients, it has led to correct diagnosis in a timely, cost-efficient manner. For our clinicians, it has helped them to eliminate ambiguity and determine the best management pathway. It has also enabled the Hospital to provide swift, seamless service to its patients while avoiding the added workload of repeated testing.

6. CONCLUSION

This case series demonstrates the impact of tailored, indication-based MRI imaging on accurate diagnosis and improved patient management. Routine imaging protocols may fail to detect certain pathologies, particularly when clinical symptoms suggest a more complex or multi-system involvement. Customizing imaging based on the patient's clinical presentation not only improves diagnostic yield but also facilitates targeted and effective treatments.

CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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