The Value of 3D SPACE MRI in Differentiating between Sequestrated Lumbar Disc Herniation and Tumors: Two Cases and Literature

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ABSTRACT

Background: Intervertebral disc herniation, defined as the protrusion or extrusion of the disc mass outside the disc space, is common and easy to diagnose on conventional Magnetic Resonance imaging (MRI) or Computed Tomography (CT) scans. However, the sequestrated disc fragments are challenging to detect, and intervertebral disc mass displacement into the dural sac, which can lead to serious neurological problems such as Cauda equina syndrome (CES). The sequestrated disc fragments do not have specific clinical or radiological characteristics that can differentiate an atypical disc mass from a tumor, making the diagnosis difficult preoperatively. Herein, we describe the use of Sampling Perfection with Application Optimized Contrast using different flip angle Evolution in Magnetic Resonance Imaging (3D SPACE MRI) in the diagnosis of the intervertebral disc fragment that mimicked a tumor.

Case presentation: In this study, we report two cases of sequestered lumbar disc herniation. The first case was a 37-year-old patient with a 2-year history of intermittent left lower limb pain that aggravates with exercise and is relieved at rest, while the second case was a 42-year-old patient with a history of 40 days of numbness and pain in the left lower limb.

Conclusion: 3D SPACE MRI is a beneficial diagnostic imaging tool for discriminating between disc mass that mimics a tumor and a tumor before surgery. If the disc fragment mimicking a tumor can be identified before the operation, open surgical treatment won't be necessary for all patients.

INTRODUCTION

The protrusion or extrusion of a disc mass outside the disc space is termed intervertebral disc herniation [1-5]. It is a common condition and easy to diagnose with conventional Magnetic Resonance Imaging (MRI) or a Computed Tomography (CT) scan [1-5]. An intervertebral disc herniation can theoretically migrate in virtually any direction within the spinal canal and has been described as on the inferior side, superior side, lateral side, intradural side, and intradural side of the spinal canal [1-5]. Preoperative diagnosis is difficult due to the lack of specific clinical or radiological features that differentiate an atypical disc mass from a tumor. The differential diagnosis of these epidural lesions includes tumors, cysts, and abscesses [1-5].

In 1973, when myelography was the gold standard for screening preoperatively, Lombardi described the first cases of intradural and posteriorly migrating disc fragments [6]. Since then, advances in radiological methods like MRI, continuous improvements in imaging techniques, and the development of research through the publication of cases in the literature have tried to facilitate their diagnosis and treatment [7].

Conventional lumbar spine MRI has been demonstrated to be an effective method for detecting disc and soft tissue pathologies, such as bulging discs, herniation, spinal canal stenosis, intervertebral foramen, and spinal cord damage [8]. However, the appearance of disc sequestration upon MRI may be similar to that of epidural tumors in rare cases [9]. Considering that CT, MRI, and gadolinium-enhanced (Gd) MRI have failed to provide a definitive diagnosis before the operation, and due to the low incidence of sequestrated disc fragments and difficulties in diagnosis and treatment, two cases of patients on whom 3D SPACE MRI was used are presented to describe the diagnostic based on the literature review.

CASES PRESENTATIONS

Case 1

A 37-year-old woman was admitted to our hospital with a 2-year history of intermittent left lower limb pain, which worsened significantly over the past month. Initial conservative treatments provided temporary relief, but recent symptoms include right lower limb pain and right foot numbness. An MRI indicated L4/5 intervertebral disc herniation. Despite acupuncture and physiotherapy, her symptoms persisted, leading to her seeking further care at our hospital, where 3D SPACE MRI revealed a prolapsed disc with a nucleus pulposus behind the L4 vertebral body.

Case 2

A 42-year-old man presented with numbness and pain in his left lower limb, persisting for 40 days. On physical examination, there was a noticeable decrease in skin sensation at the back of his left thigh and on both the inside and outside of his lower leg. Diagnostic imaging via a 3D SPACE MRI of the lumbar spine revealed significant swelling and thickening of the left L3 nerve, which was being compressed by a herniated intervertebral disc. The left femoral nerve exhibited similar swelling and thickening. The patient underwent percutaneous discectomy under local anesthesia, followed by treatments for symptom relief and infection prevention. The histopathological analysis confirmed the presence of a herniated intervertebral disc. Following the treatment, the patient experienced a successful recovery of motor function in his right foot.

DIFFERENTIAL DIAGNOSIS

Several medical conditions share symptoms with a sequestrated disc fragment, making diagnosis more complex. These include infections such as epidural abscesses, various types of tumors including meningiomas, metastases, lipomas, lymphomas, and hemangiomas, degenerative diseases like synovial cysts and osteophytes in facet joints, as well as other conditions like postoperative fibrosis [10-12].

DISCUSSIONS

The most commonly used imaging approach for assessing spinal disorders is MRI. Migrated disc fragments generally appear hyperintense on T2-WI and hypointense on T1-WI when compared to the disc origin [13]. After contrast injection, rim enhancement is usually observed surrounding the extruded disc fragment and is associated with the existence of an inflammatory response and neovascularization [14]. Although these characteristics are present in the majority of cases, MRI alone would only be able to confirm the exact diagnosis in some of them, especially when there are accompanying abnormalities in the disc space and adjacent endplates. The low prevalence of these posteriorly migrating discs relative to other more common spinal lesions presenting with a similar radiological appearance contributes to common misinterpretation [12].

Spine disc herniation is a common disease. If the fibrous ring of the intervertebral disc is intact, the nucleus pulposus is limited and will not shift. If the annulus fibrosis of the intervertebral disc ruptures locally, the nucleus pulposus can be dislocated. If the prolapsed part of the nucleus pulposus is completely separated from the disc, it can move freely upward, downward, or backward, forming a sequestrated disc fragment [7]. Compared to conventional types of disc protrusion, sequestrated disc fragments lead to much more serious clinical symptoms, such as more severe pain. The imaging detection of sequestrated disc fragments is also much more difficult than that of other types of disc protrusion. Possible reasons are as follows: (1) the sequestrated disc fragment is often of small size; (2) the sequestrated disc fragment is usually located at the lateral recess of the spinal canal. The detection of the sequestrated disc fragment depends on the experience of radiologists. Compared to radiologists with senior professional titles, those with low professional titles are more likely to miss a sequestrated disc fragment.

There is no doubt that a CT scan can be used to detect sequestrated disc fragments [15]. Continuous and thin scanning slices are needed to cover both discs and vertebral bodies. Scanning is generally performed on the transverse section. In some centers, the scanning scope only covered the discs but did not cover the vertebral bodies, making the detection of a sequestrated disc fragment of the lateral recess impossible. Because of the poor soft-tissue resolution of CT, sequestrated disc fragments beyond the level of the disc are easy to miss, especially for doctors with inadequate experience. Thus, MR with excellent soft-tissue resolution is required to validate the presence of a sequestrated disc fragment. When imaging the lumbar, are always used, while 3D fast spin echo (FSE) sequences are not frequently used due to the long acquisition time. 2D FSE is generally performed on the sagittal and transverse planes, but seldom on the coronal plane, which better displays the segment of the nerve in the lateral recess. When proton density or T2-weighted 2D FSE, is performed on the transverse plane, both discs and vertebral bodies should be covered, and the imaging plane should be parallel to the intervertebral disc. As discs are not parallel to each other, several groups of 2D FSE are needed to be performed on the transverse plane. Unfortunately, in some centers, some mistakes are made as follows: 1) transverse slices do not cover the vertebral body, or 2) sagittal slices are too thick to display intraspinal lesions of small sizes. These mistakes make the detection of a sequestrated disc fragment difficult or even impossible. To display possible-present sequestrated disc fragments, many thin slices should be used, resulting in a very long acquisition time. Another way to solve this problem is to use 3D sequences, which also have many thin slices.

3D SPACE T2WI is a powerful sequence, providing high spatial resolution, excellent tissue contrast, and adequate image quality. 3D-SPACE is a sophisticated T2-weighted 3D turbo spin-echo imaging technology [16]. It differentiates itself by using various flip angles rather than the standard pulse sequences. This technology is highly regarded for its high-resolution and contrast capabilities, making it fundamental in

medical conditions requiring precise anatomical visualization. It speeds up picture capture and offers thin-section imaging in a reasonable amount of time. These conditions include tumor differentiation, precise brain imaging, and comprehensive spinal evaluations, where its more successful imaging capabilities are essential [17]. Volumetric interpolated breath-hold examination (VIBE) is a 3D T1 weighted sequence with high spatial resolution and is widely used in the abdomen due to its short acquisition time. Currently, there are no publications that combine SPACE and VIBE to evaluate atypical lumbar disc herniation.

CONCLUSIONS

The absence of specific clinical or radiological characteristics of intervertebral disc herniation makes it more challenging to differentiate atypical disc mass from a tumor. There is no doubt that 2D FSE MRI sequences and CT can be used to detect sequestrated disc fragments, but it is challenging and highly dependent on the expertise of the radiologist. Interestingly, 3D SPACE T2WI could provide high resolution with excellent tissue contrast and adequate image quality. This technique could provide an accurate diagnosis and might minimize the rate of open surgeries in patients.

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FIGURES

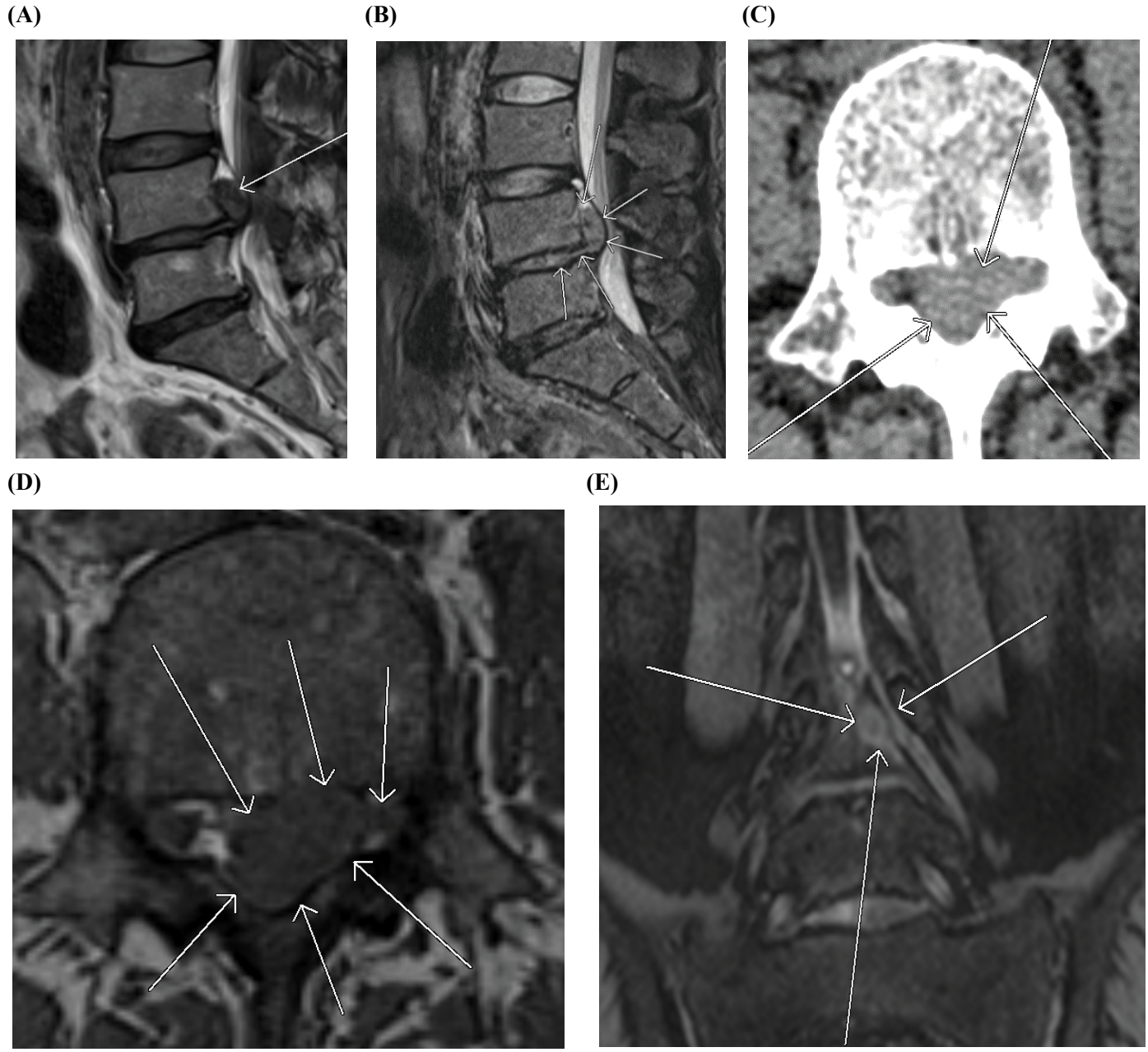

Figure 1 of case1: (**A**) sagittal T2-weighted MRI, showing an extruded disc of L4/5 with the nucleus pulposus moving upwards, located in the spinal canal behind the L4 vertebral body, showing an oval low-signal nodule (indicated by arrow). (**B**) Sagittal T2-weighted MRI with fat suppression shows the signal of the extruded nucleus pulposus is similar to that of the maternal nucleus pulposus and is connected with a narrow and long neck (indicated by arrows). The cauda equina nerve behind the extruded nucleus pulposus is compressed and thinned. (**C**) Across-sectional CT image of the middle level of the L4 vertebral body, it can be seen that there is an irregular soft tissue (indicated by arrows) in front of the cauda equina nerve in the spinal canal, and the boundary is not clear. (**D**) Axial T1-weighted MRI of the middle level of the L4 vertebral body. The oval low signal nodules in front of the cauda equina nerve in the spinal canal can be seen. The fat space around the nerve root of the right lateral recess is clearly visible, while the nerve root and fat space of the left lateral recess are blurred. (**E**) Coronal T2-weighted SPACE image, shows that the free nucleus pulposus is located above the L4/5 intervertebral space, and the left L4 nerve root lateral recess is compressed and thinned by the nucleus pulposus (arrows).

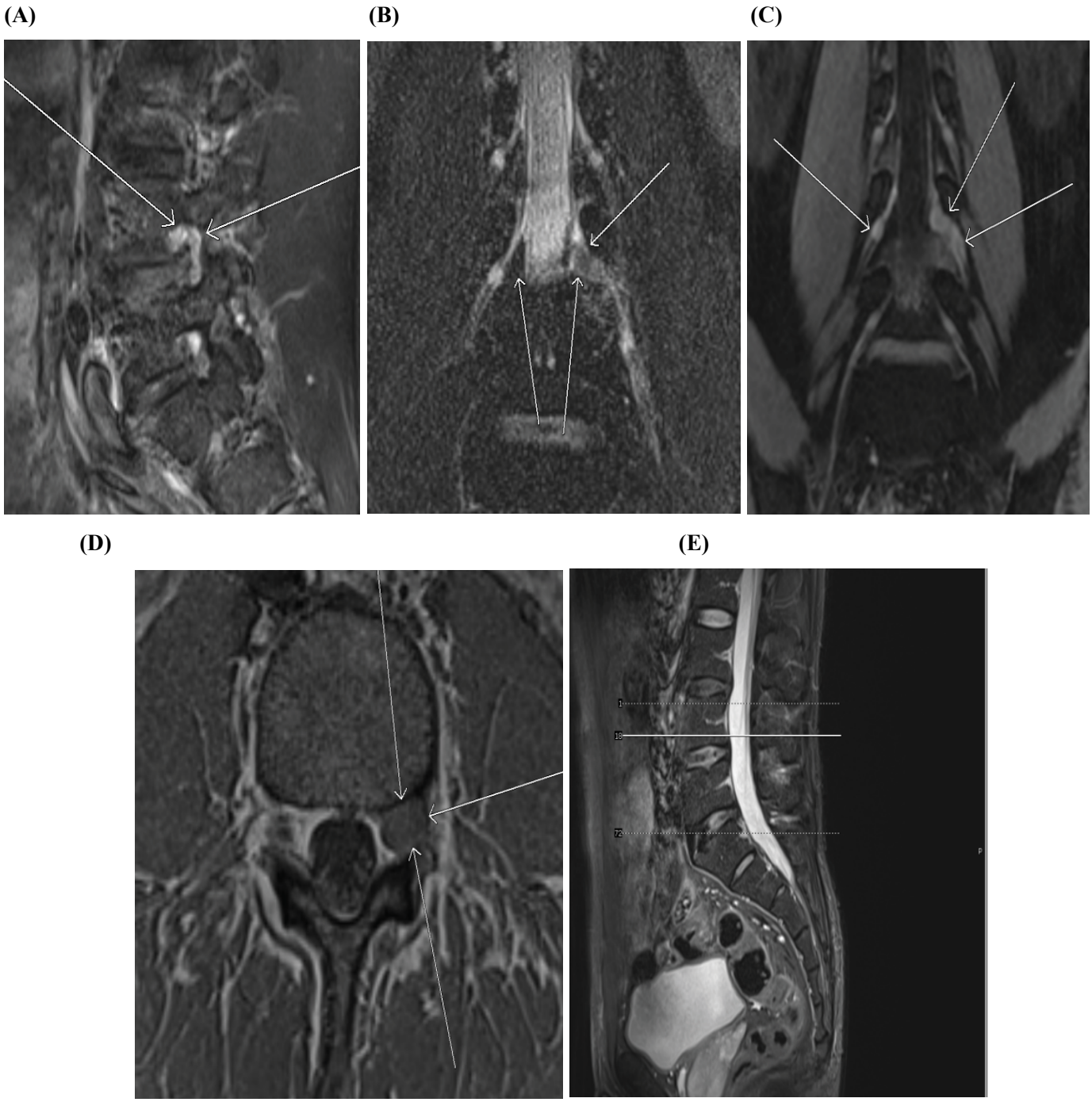

Figure 2 of Case 2: (**A**) Sagittal T2-weighted MRI with fat suppression, showing the "7" shaped high signal (indicated by arrows) behind the L4/5 disc, indicating that the extruded nucleus pulposus is moving downwards. (B) Coronal T2 weighted SPACE image. showing a regular triangular fat space on the inner side of the right L4 nerve lateral recess, while the left L4 nerve lateral recess is not clearly displayed. The inner fat space basically disappears and is occupied by the nucleus pulposus (indicated by arrows). (C) Coronal DESS image, shows that the morphology of the right L4 is normal, while the left L4 nerve is significantly thickened and swollen (indicated by arrows). (D) Axial T1-weighted MRI with fat suppression of the lower third level of the L4 vertebral body. It can be seen that the left nerve running area has massive low-signal soft tissue (indicated by arrows), and the peripheral fat space disappears. (E) Sagittal T2-weighted MRI with fat suppression.

KEYWORDS

Disc Herniation; Sequestrated Disc Fragments; MRI

ABBREVIATIONS

3D SPACE MRI = Three-Dimensional Sampling Perfection with Application optimized Contrasts using different flip-angle Evolutions.
CES = Cauda equina syndrome
MRI = Magnetic Resonance imaging
CT = Computed Tomography
VIBE = Volumetric interpolated breath-hold examination

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