Case Report

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Computed Tomography Myelogram Versus Magnetic Resonance Imaging for Cervical Stenosis: A Case Report and Review of Literature

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1. Abstract

1.1. Introduction:
Advancements in imaging modalities, particularly in CT Myelography and MRI, have greatly improved diagnosis and surgical planning for spinal surgeries, notably in cases of cervical myelopathy affecting millions of Americans, especially the elderly. CT myelography uses iodinated contrast to identify pathological compression, while remaining compatible with implanted devices such as pacemakers which create interference in other imaging methods. Proper diagnosis and visualization impact surgical decision making including anterior vs posterior approaches related to the source of compression.

1.2. Case:
A 53-year-old male with a medical history of gastroparesis status post gastric pacemaker and a prior C6-C7 Anterior Cervical Discectomy and Fusion (ACDF) presented to clinic due to progressive myelopathy. Pre-operative CT Myelogram of the cervical spine demonstrated cervical stenosis at C3-C4 with ventral cord flattening and cerebrospinal fluid patency dorsally, and flexion extension x-ray confirmed slight mobility at that level. The patient was taken to the operating room for a C3-C4 ACDF. On post-operative day one, the patient endorsed worsening weakness in his hand grip and interosseous muscles. After discussion with radiology, the pacemaker was deemed to be MRI compatible with use of the brain receiver. MRI of the cervical spine demonstrated severe central canal stenosis secondary to ligamentum flavum buckling posteriorly. The patient was subsequently taken for a C3-C4 laminectomy and fusion. Post-operatively, the patient's motor exam improved to full strength.

1.3. Conclusion:
Different imaging modalities can yield varying assessments of stenosis severity. The integration of advanced imaging techniques enhances surgical decision-making; however, discrepancies among these modalities may result in divergent surgical plans. Further research is warranted to elucidate the clinical significance of these differences in imaging assessments.

Keywords:
Myelogram, MRI, Cervical, Stenosis

2. Introduction

Advancements in imaging modalities for spinal surgery have significantly enhanced surgical planning. Computed Tomography (CT) Myelography employs iodinated contrast agent within the cerebrospinal fluid space to delineate pathological compressions. Additionally, Magnetic Resonance Imaging (MRI) has increasingly been utilized for comparable diagnostic objectives. A notable advantage of myelography is its compatibility with implanted devices, such as defibrillators and pacemakers, which allows for comprehensive imaging without the interference typically associated with other modalities. Congenitally narrow spinal canal, a condition characterized by a reduced diameter of the spinal canal present at birth, can have significant implications for predisposition of cervical myelopathy and compression which may cause pain, numbness and weakness [3]. Cervical myelopathy is a condition that impacts approximately 605 per million Americans annually, with its prevalence increasing among older individuals [5]. A critical determinant in selecting an appropriate surgical approach is the underlying etiology of the compression, particularly whether it is predominantly dorsal or ventral in nature. Anterior cervical discectomy and fusion is often considered a viable option for patients presenting with ventral compression, provided there are no additional pathological findings, such as ossification of the posterior longitudinal ligament. Conversely, posterior decompression and fusion may be indicated for cases involving ligamentous hypertrophy and facet joint overgrowth.

We present a case involving a patient presented to the neurosurgery clinic with progressive myelopathy and required a CT myelogram for work-up due to presence of the gastric pacemaker, preventing him from undergoing

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an MRI. Post-operatively, the patient exhibited new weakness. After discussion with the patient and radiology department regarding the risks of MRI in the presence of the gastric stimulator which was determined to be MRI conditional, an MRI was completed and revealed significant postoperative buckling of the ligamentum flavum. He was taken for posterior decompression and fusion with resolution of symptoms.

3. Case

A 53-year-old male with a medical history that includes gastroparesis status post "MRI-incompatible" gastric pacemaker implantation, hypertension, hyperlipidemia, diabetes mellitus, and a previous C6-C7 anterior cervical discectomy and fusion, presented to clinic with progressive myelopathy characterized by worsening gait dysfunction, bilateral upper extremity paresthesia, decreased hand dexterity, and weakness in both upper extremities. A pre-operative CT myelogram of the cervical spine revealed cervical stenosis at the C3-C4 level, during which the patient had an anaphylactic reaction during the myelogram (Figures 1 and 2).

Figure 1: Sagittal cut CT Myelogram of the cervical spine demonstrating canal stenosis with multiple measurements <13mm of width of the canal.

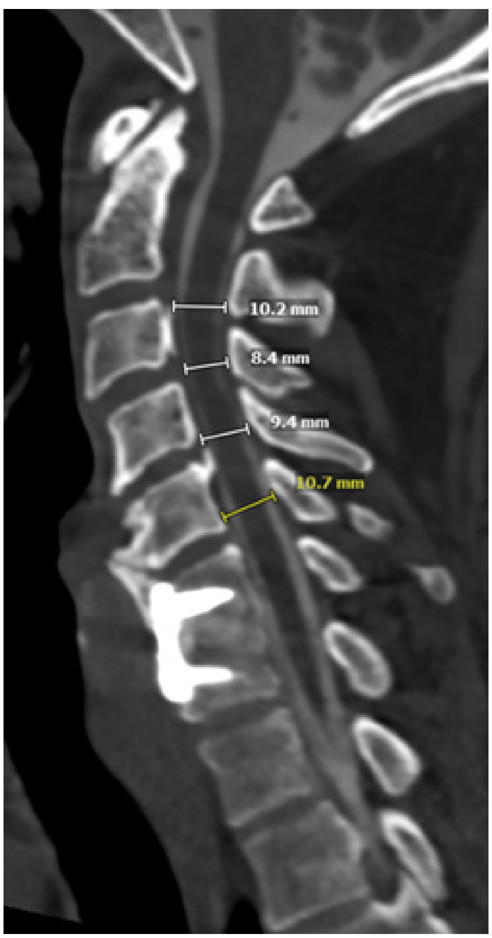


Figure 2: Axial cut CT myelogram scan of the cervical spine highlighting CSF signal surrounding the spinal cord.

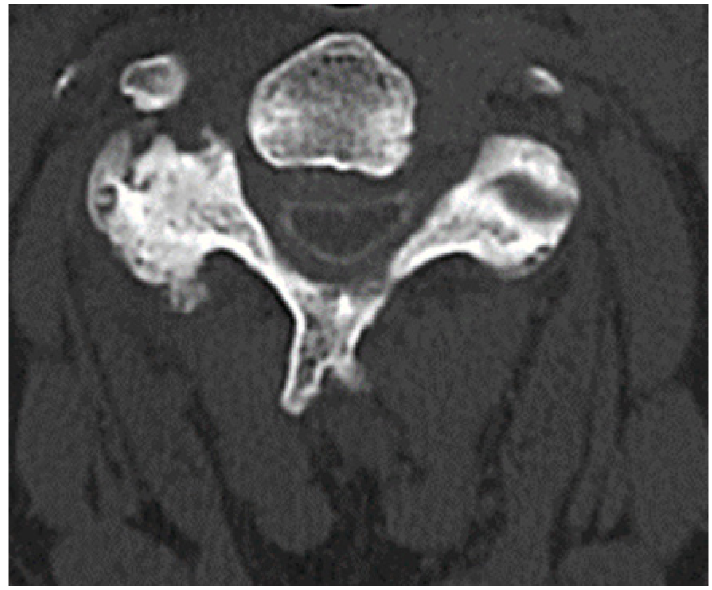
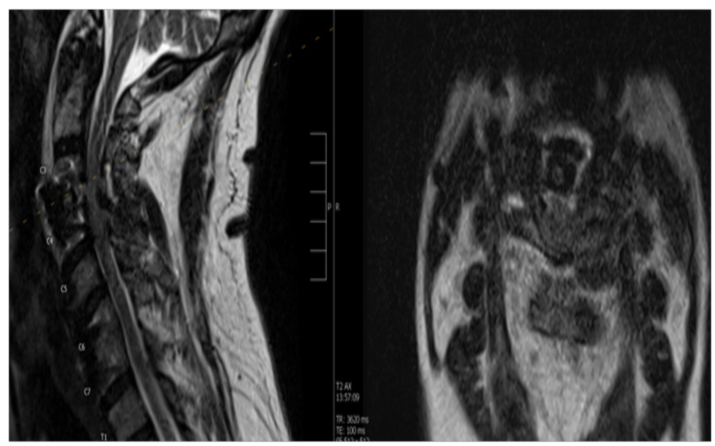


Figure 3: Sagittal and axial cut T2 MRI of the Cervical Spine demonstrating severe cervical canal stenosis at C3-C4 at the level of the recently placed ACDF with dorsal ligamentum flavum buckling.



The patient underwent a C3-C4 anterior cervical discectomy and fusion, assisted by an otolaryngologist for surgical exposure, given the prior cervical surgery. Initially post op, the patient experienced significant improvement in his symptoms. On post-operative day one, the patient reported exacerbated weakness in hand grip and interosseous muscles, necessitating transfer to the intensive care unit with a mean arterial pressure target of greater than 85 mm Hg, along with the initiation of dexamethasone therapy. Differential diagnosis at that time included post-operative epidural hematoma or instrumentation failure. An x-ray was performed showing stable position of the instrumentation (Figure 4).

Figure 4: Post-operative sagittal cervical x-ray with prior C6-C7 ACDF and new C3-C4 ACDF.

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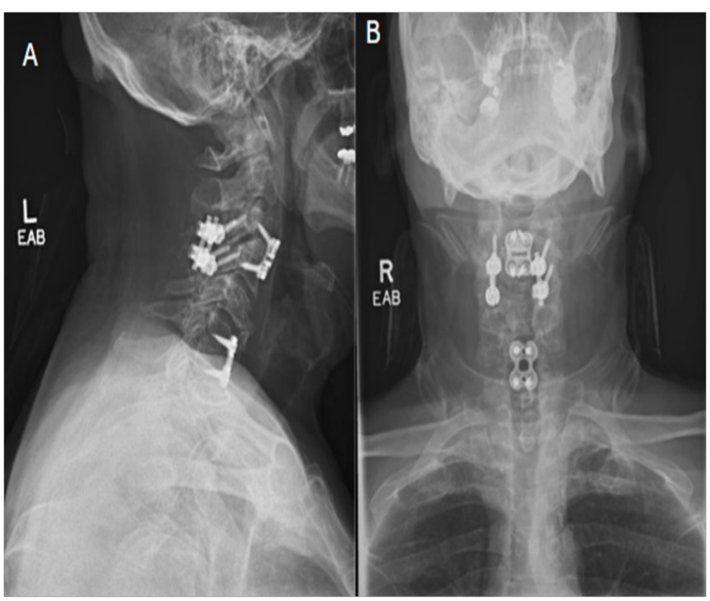
Given his prior anaphylactic reaction during the first myelogram and the urgent nature of his neurologic decline, the patient was unable to receive pre-treatment of the contrast allergy in order to obtain a new CT myelogram. After consultation with our institution's senior neuroradiology partners, the pacemaker was deemed MRI-conditional, and using the brain-receiver, urgent MRI of the cervical spine was completed. This imaging revealed severe central canal stenosis due to posterior buckling of the ligamentum flavum. Subsequently, the patient underwent a C3-C4 laminectomy and fusion (Figure 5). Post-operatively, the patient's motor examination showed improvement to full strength, with resolution of paresthesia, and he was discharged home on post-operative day five.

Figure 5: Post-operative lateral (A) and anterior-posterior (B) cervical x-ray with prior C6-C7 ACDF and new C3-C4 ACDF and new C3-C4 posterior decompression and fusion.



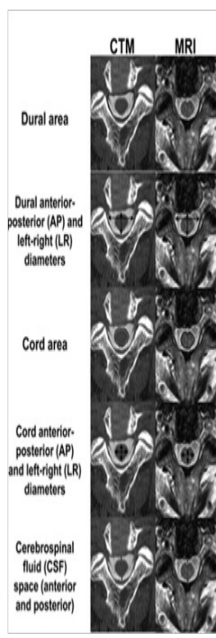
4. Discussion

Currently, there is no universally accepted standard for diagnostic imaging in patients with congenitally narrow spinal canals. However, the existing literature suggests that clinicians and surgeons should approach myelograms and MRIs with the understanding that assessments from these modalities may not be entirely equivalent, potentially influencing surgical decision-making [1, 2].

5. Differences In Imaging Modalities

Toshitaka et al. compared MRI and CT myelography for evaluating the cross-sectional morphology of the cervical spine. In this study, 45 patients underwent both MRI and CT myelography, with measurements taken for the dural area, anteroposterior (AP) and lateral diameters of the dura, the area of the spinal cord, and the corresponding diameters, as well as the cerebrospinal fluid (CSF) space. The results demonstrated that CT myelography overestimated both the dural area and its diameters. In contrast, MRI was found to overestimate the spinal cord area, while CT myelography similarly overestimated the CSF areas. Overall, CT myelography consistently overestimated all dead spaces (dural and CSF) while underestimating the size of the spinal cord and thus demonstrating reduced sensitivity in detecting stenosis [2] (Figure 6).

Figure 6: Summary of radiographic findings in Naganawa et al.



	CTM	MRI	CTM/MRI
Dural area	+	-	+11.5%
Dural anterior-posterior (AP) and left-right (LR) diameters	AP: + Lateral: +	AP: - Lateral: -	AP: 18.2% Lateral: 15.2%
Cord area	-	+	-8.9%
Cord anterior-posterior (AP) and left-right (LR) diameters	AP: - Lateral: -	AP: + Lateral: -	AP: -1.7% Lateral: -3.1%
Cerebrospinal fluid (CSF) space (anterior and posterior)	Anterior: + Posterior: +	Anterior: - Posterior: -	Anterior: 31.5% Posterior 52.2%

Additionally, Yi et al. conducted a comparative study on the efficacy of CT myelography versus MRI in detecting cervical disc herniations. The study involved three radiologists who assessed CT myelograms and 1.5 Tesla MRIs from C2-3 to C6-7 in a cohort of 51 patients. Both inter-observer and inter-modality agreements were evaluated. The findings indicated that CT myelography tended to underestimate the size of disc herniations relative to MRI, with underestimations occurring in

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16.4% of bulging discs, 32.9% of disc protrusions, and 66.7% of disc extrusions. Conversely, CT myelography overestimated the severity of non-pathological disc herniations in comparison to MRI, affecting 9.6% of normal discs, 21.8% of bulging discs, and 3.8% of disc protrusions [1].

6. Devices Affecting Mri Compatibility

The degree of MRI compatibility varies among peripheral devices, including defibrillators, pacemakers, and neuromodulators. An MRI-compatible (MRI-safe) device indicates a very low risk of malfunction following MRI exposure, although reprogramming may be required post-imaging to ensure optimal function. These devices are composed of electrically nonconductive, non-metallic and non-magnetic materials. MRI conditional devices may be scanned but only under certain circumstances including restrictions on static field strength, maximum spatial field gradient, dB/dt limitations (usually only applicable to active implants), specific absorption rate (SAR) limits, anatomic location of isocenter, scan duration and any other conditions needed for safe use of the device (i.e. types of coils that may be used) while MRI non-compatible (Un-safe) devices are contraindicated due to concerns such as device malfunction, heating, or migration. These classifications are instrumental in guiding clinical decision-making, and industry trends are increasingly favoring the development of more MRI-compatible devices in response to the widespread use of MRI scanning [6].

Increased attention to the compatibility and clearance of implantable devices for MRI scanning is essential. Russo et al. conducted a comprehensive analysis of patients with non-conditional defibrillators and pacemakers, revealing no instances of device damage during MRI procedures. Moreover, advancements in device technology have enhanced MRI compatibility, potentially streamlining the clearance process for these devices [4].

7. Conclusion

Different imaging modalities can yield varying assessments of stenosis severity. The integration of advanced imaging techniques enhances surgical decision-making; however, discrepancies among these modalities may result in divergent surgical plans. Further research is warranted to elucidate the clinical significance of these differences in imaging assessments.

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