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Clinical Case Study

Delineation of Pathologies in Orbit Imaging with Advanced intelligent Clear-IQ Engine (AiCE) Deep Learning Reconstruction

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Introduction

Magnetic Resonance Imaging (MRI) is useful in diagnosing pathology within the ocular compartment, including the optic nerve, extraocular muscles, and other anatomical structures around and behind the eye. In this paper, we will look primarily at pathology as it relates to thyroid ophthalmopathy. In the early stages of thyroid ophthalmopathy, the extraocular muscles are infiltrated with inflammatory cells, leading to intramuscular edema and enlargement. When assessing for active disease and potential treatment options, MR imaging is uniquely valuable due to its superior soft-tissue contrast which allows the detection of active inflammation in addition to quantification of the degree of muscular enlargement and proptosis. Given the relatively small size of the orbital components, MR evaluation often necessitates thin slices and high resolution imaging for accurate anatomic detail, which can, paradoxically, hinder diagnostic quality due to low SNR.

Advanced intelligent Clear-IQ Engine (AiCE) DLR is the worlds-first fully integrated Deep Learning-based Reconstruction technology introduced by a major MR vendor. AiCE DLR is seamlessly integrated into the MR reconstruction pipeline to effectively remove Gaussian noise from MR images, hence, improving SNR.[1] The improved SNR could be used to enhance resolution and/or shorten scan time.

Clinical Cases

Case #1

This patient has a history of thyroid eye disease and was imaged following partial thyroidectomy and Tepezza treatment with residual bilateral eye pain on clinical exam. Orbital MRI reveals asymmetric enlargement and edema within the right medial and inferior recti compared to the contralateral side.

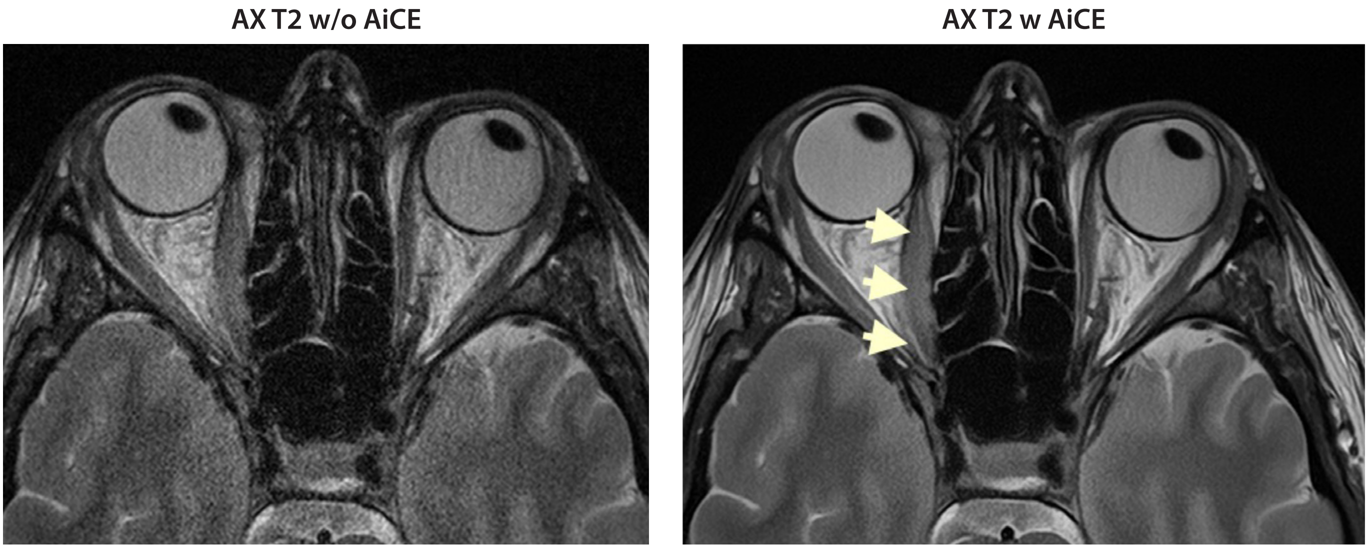

Figure 1.1 The view of the orbits used to evaluate thyroid orbitopathy, demonstrating the globe and medial and lateral rectus muscles. Axial T2 Fast Spin-Echo (FSE) without AiCE (left image) and with AiCE (right image) acquired with 14 cm FOV, 352 matrix size, and 2.5 mm slice thickness. Asymmetric enlargement of the right medial rectus muscle is demonstrated. Fusiform enlargement and internal T2 signal can be clearly visualized on the image with AiCE (right image).

COR STIR w/o AiCE **COR STIR with AiCE**

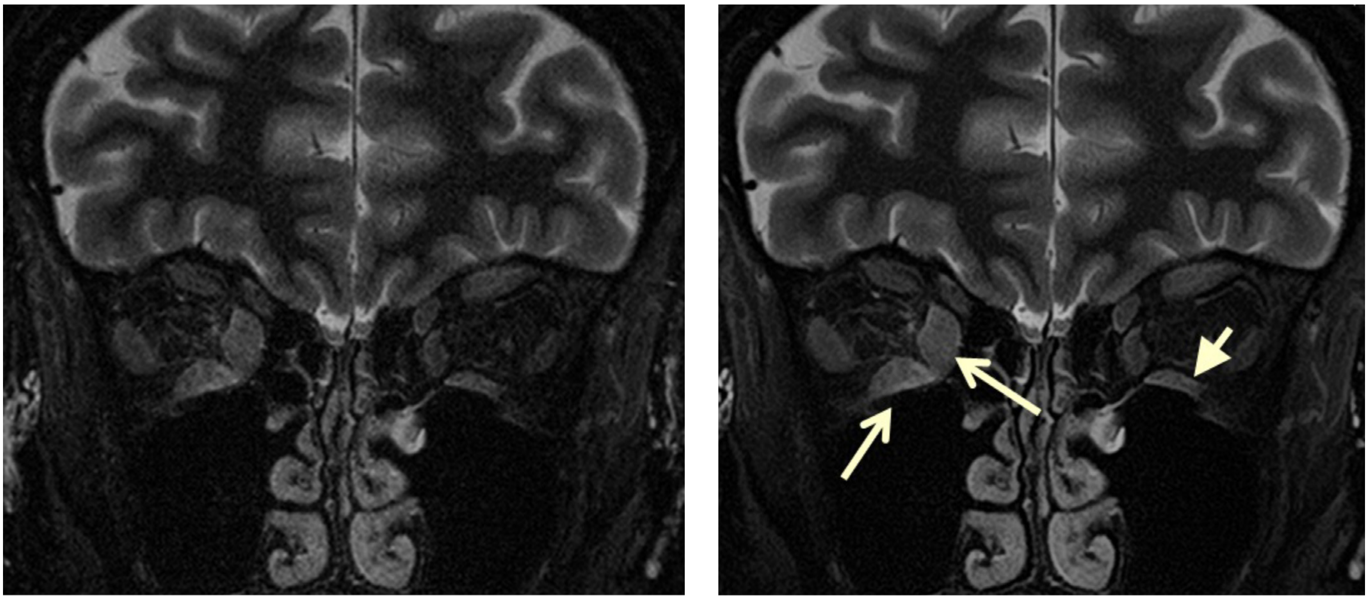

Figure 1.2 Coronal view of the orbits demonstrating the cross-section of the rectus muscles. Coronal STIR without AiCE (left) and with AiCE (right) images that were acquired with 14cm FOV, 320 matrix size, and 3 mm slice thickness. Asymmetric enlargement and edema of the right inferior and medial recti is clearly demonstrated compared to the contralateral side (arrows).

Coronal STIR imaging usually has lower SNR and resolution compared to T2 FatSat FSE imaging. However, STIR offers advantages near the skull base and sinuses because it is less affected by susceptibility at the air-tissue interface. As seen on the right, AiCE improves image quality by effectively removing the noise associated with higher resolution STIR imaging. In this case, AiCE assists in evaluating the left inferior rectus muscle, which is subtly involved in this patient with thyroid eye disease and residual eye pain.

Case #2

In this case, there is diffuse enlargement of the extraocular muscles associated with bilateral proptosis, compatible with known thyroid orbitopathy. Lacrimal glands and optic nerves are normal in size and appearance.

AX T2 w/o AiCE **AX T2 with AiCE**

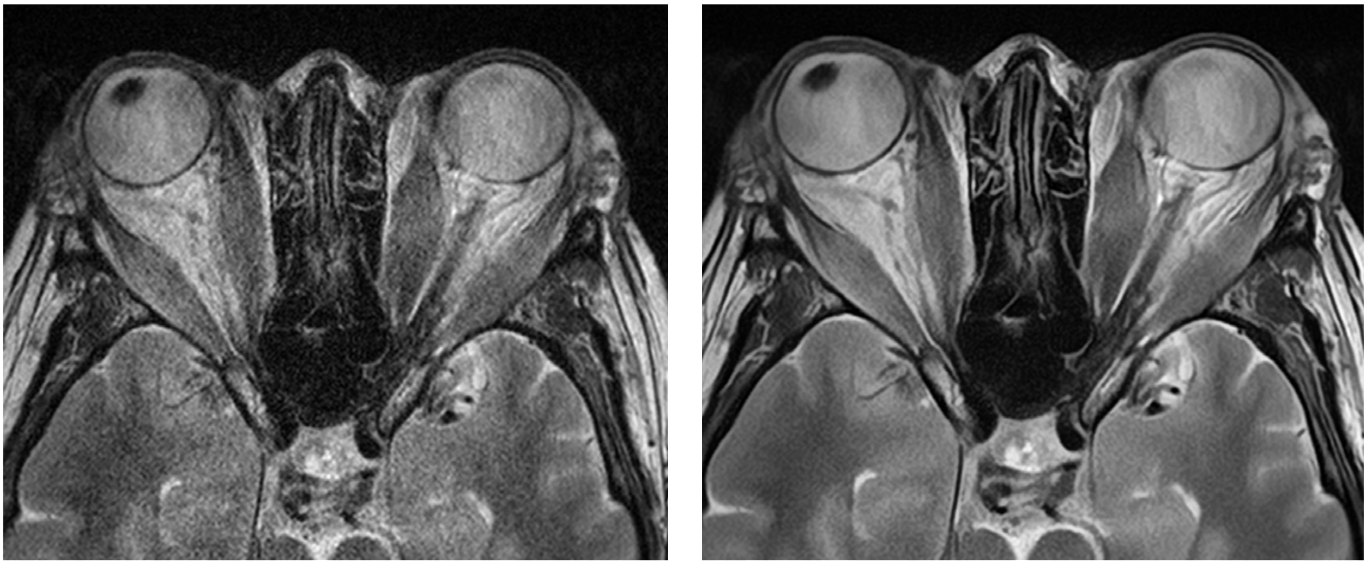

Figure 2.1 The view of the orbits used to evaluate thyroid orbitopathy, demonstrating the globe and medial and lateral rectus muscles. Axial T2 FSE without AiCE (left image) and with AiCE (right image) were acquired with 14 cm FOV, 352 matrix size, and 2.5 mm slice thickness. In this case, AiCE allowed for a better depiction of subtle details in anatomy and pathology in the setting of motion artifact.

Case #3

This case exemplifies the selective advantage of AiCE imaging in combination with STIR sequences to enhance resolution while decreasing artifact around the skull base and sinuses.

T2 FatSat | **T2 STIR w/o AiCE** | **T2 STIR with AiCE**

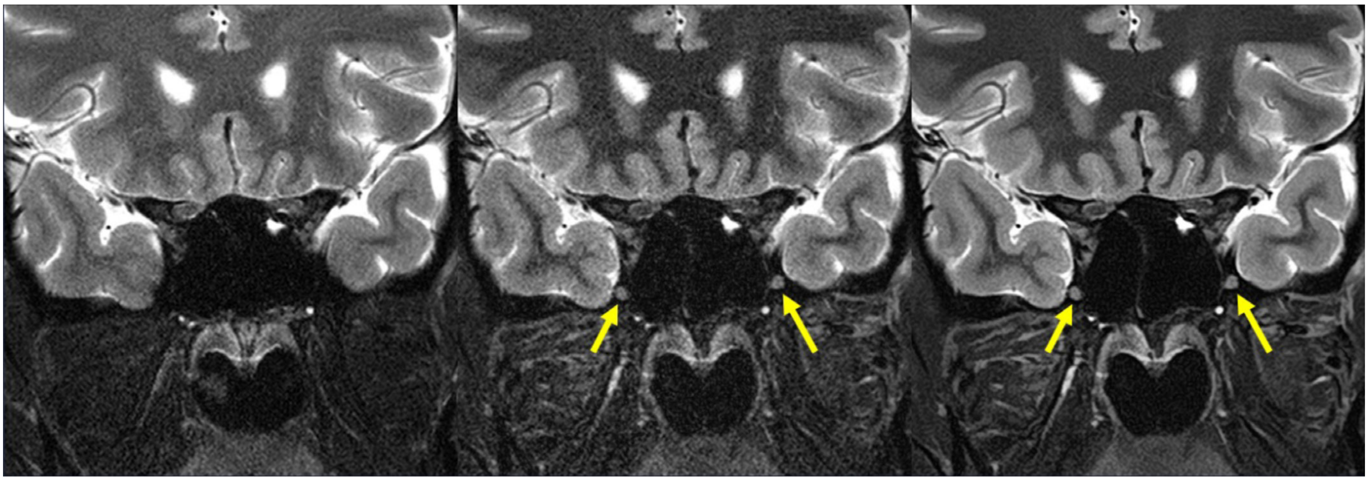

Figure 3.1 Coronal imaging at the level of the central skull base, demonstrating the pterygoid plates and vidian canals/foramen rotundum (arrows). The coronal T2 STIR reconstructed with AiCE (right-most image) reveals the maxillary branch of the trigeminal nerve (V2), which is not visible in the coronal T2 FSE with FatSat reconstructed without AiCE (left-most image) due to susceptibility. STIR, on the other hand, is less sensitive to susceptibility and optimal for nerve visualization, but can be problematic in orbit imaging due to low SNR and low resolution. Canon's AiCE technology can efficiently remove noise making STIR a viable option for imaging of the orbit and the small skull base structures, including the foramina. As seen in the far-right image, AiCE DLR allows STIR to be accomplished with sufficient SNR and resolution in this challenging region. The images were acquired with 14 cm FOV, 320 matrix size, and 3 mm slice thickness.

Summary

In this case study, it was demonstrated that AiCE DLR allows high-resolution and high-SNR orbit MR imaging, which in turn improves visualization of pathologies that would be otherwise difficult to detect.

Acknowledgments

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[1]AiCE provides higher SNR compared to typical low pass filters

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