ROLE OF DIFFUSION WEIGHTED IMAGING MRI IN THE EVALUATION OF GRAVES' ORBITOPATHY

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Introduction

Graves' orbitopathy (GO) is the most serious extra-thyroidal manifestations of Graves' disease. It typically follows a predictable biphasic course: an initial active phase lasting 6-18 months, followed by an inactive phase characterized by fibrosis and fatty infiltration. The Clinical Activity Score (CAS) is commonly used to assess disease activity; however, it is limited to the visible anterior segment of the orbit, and it may not detect potentially sight-threatening dysthyroid optic neuropathy in cases with low scores. Various imaging modalities such as computed tomography, magnetic resonance imaging, ultrasound, and colour doppler imaging are utilized to diagnose and monitor the activity of Graves' orbitopathy. Among these, MRI with Diffusion-Weighted Imaging (DWI) is emerging as a valuable non-invasive tool for evaluating disease activity and predicting treatment response. Non-EPI-DWI, in particular, offers notable advantages over echo-planar DWI, including improved resolution due to thinner-section images and the use of refocusing pulses for each recorded EPI-DWI sequence, which help to minimize distortions and artifacts at the air-bone interface.

Aim of the work

The aim of this study was to explore the diagnostic potential of Non-EPI-DWI of the orbits in Graves' disease.

Methods

The research included 20 patients with graves' orbitopathy referred from a multidisciplinary thyroid eye disease's clinic to the radiology department of Alexandria Main University Hospital for MR imaging (coronal non -EPI DWI and coronal T2 fat suppressed images of both orbits). The Radiological findings were correlated with the Clinical Activity Score (CAS).

Results

The study identified a strong positive correlation ($p<0.001$) between the Clinical Activity Score (CAS) and Apparent Diffusion Coefficient (ADC) values in 160 extraocular muscles (EOMs), with higher ADC values in active cases compared to inactive ones ($p<0.001$). An ADC value of >1.2 x10^{-3} was found to be the optimal cut off for distinguishing active from inactive patients. Additionally, the quantitative radiological assessment using Non-EPI DWI proved more accurate than CAS in predicting EOM activity, showing outstanding diagnostic performance with 100% sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Table 1: Illustrated the optimum cut off value x10^{-3} for each EOM as well as all EOMs activity

	AUC (95% CI)	p-value	Cutoff	Sensitivity %	Specificity %	PPV	NPV
Inferior recti muscles	0.936	<0.001*	>1.2	91.67	81.25	88.0	86.7
Medial recti muscles	0.866*	<0.001*	>1.2	83.33	81.25	87.0	76.5
Superior complex muscles	0.911	<0.001*	>1.2	95.83	75.0	85.19	92.31
Lateral recti muscles	0.944	<0.001*	>1.2	88.5	88.0	91.3	82.4
Overall recti muscles	0.910	<0.001*	>1.2	90.0	81.25	87.8	83.9

Table 2: showed The (sensitivity, specificity , accuracy ,positive and negative predictive values using SSPS statics) of both quantitative radiological assessment as well as the CAS in detecting EOMs activity (n = 20#)

	Non-EPI DWI (ADC values) %	CAS %
SENSITIVITY	100	75
Specificity	100	100
Positive predictive value	100	100
Negative predictive value	100	42.86
Accuracy	100	78.95

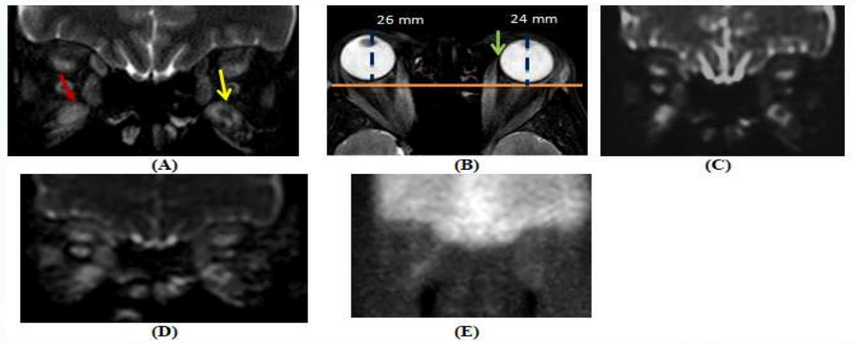

Figure1: Magnetic resonance images of both orbits in clinically active patient displayed: (A) coronal and (B) axial T2-weighted fat-suppressed images illustrating: moderate bilateral symmetrical enlargement of EOMs (**yellow arrow**), sparing their tendinous portion (**green arrow**), this is accompanied by a corresponding T2 hyperintense signal in the EOMs (**red arrow**) and mild proptosis (**C), (D), and (E)** are non-EPI diffusion-weighted images (**DWI**) with b0 and b1000 values, as well as an ADC map showing the following ADC values: the Right inferior rectus (IR) 1.9, medial rectus (MR) 1.5, superior rectus (SR) 1.8, and lateral rectus (LR) 1.5 x 10^{-3} mm²/sec. The Left inferior rectus (IR) 1.7, medial rectus (MR) 1.8, superior rectus (SR) 1.8, and lateral rectus (LR) 1.5 x 10^{-3} mm²/sec

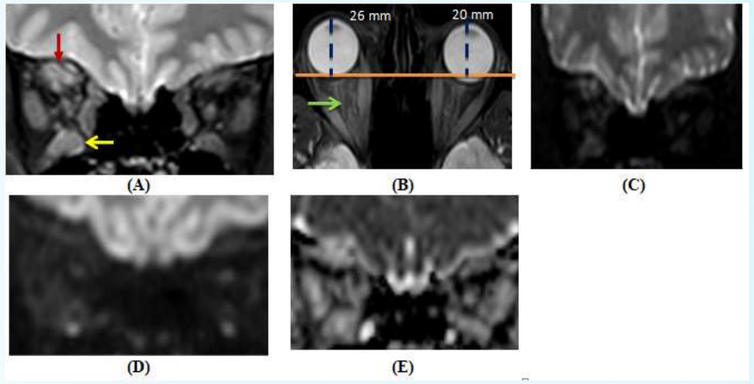

Figure 2: Magnetic resonance images (MRI) of both orbits in clinically inactive patients illustrated : (A) coronal and (B) axial T2-weighted fat-suppressed image showing moderately bilateral asymmetrical enlargement of the EOMs (red arrow) more pronounced on the right orbit associated with T2 hyperintense signal (yellow arrow) and stranding of retro-orbital fat (green arrow) more on the right side and mild right sided (C), (D) and (E) coronal NON –EPI- DWI images with b0, b1000 values and ADC map with ADC values as follow: Right IR 1.5, MR 1.4, SR 1.45 and LR 1.38 X10^{-3} mm²/sec .Left IR 1.36, MR 1.4, SR 1.3 and LR 1.3X10^{-3} mm²/sec

Conclusion

Diffusion-weighted MRI (DW-MR) is an effective non-invasive imaging tool for detecting Graves' orbitopathy activity. When combined with the Clinical Activity Score (CAS), it enhances sensitivity in assessing disease activity and predicting treatment response. The Apparent Diffusion Coefficient (ADC) value is a useful quantitative measure for distinguishing between active and inactive patients. Incorporating coronal non-EPI DWI sequences into conventional MRI minimally increases examination time while significantly improving diagnostic accuracy. Therefore, it is advisable to use non-EPI DWI sequences even if only one CAS parameter is positive, to prevent potential sight-threatening dysthyroid optic neuropathy associated with low CAS scores.