# Head & Neck: DWI and IVIM in the Orbit at 3T



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#### **Patient history**

A 38-year-old woman presented with rapidly worsening, painless monocular vision loss of her left eye, which began six months prior to the encounter. The clinical exam revealed a visual acuity of 1.4/10 and a central scotoma in the left eye. Oculomotricity was normal. An MRI was performed.

#### **Morphological findings**

The MRI protocol included an axial unenhanced T1-weighted spin echo sequence, a coronal T2-weighted Dixon, a dynamic-contrast enhancement perfusion sequence, a coronal fat sat post-contrast T1-weighted spin echo sequence, an axial high resolution postcontrast proton density-weighted spin echo sequence and an IVIM acquisition based on DW images acquired using 15 b-values (0, 10, 20, 40, 80, 110, 140, 170, 200, 300, 400, 600, 800, 1000, 2000 s/mm<sup>2</sup>) at 3T.

The patient was asked to look at a fixed point during the acquisitions in order to prevent kinetic artifacts from eye movements. Conventional MRI showed a 30 mm mass located in the left orbit, displacing the eye anteriorly, with a high intensity on T2-WI and progressive filling of the lesion after contrast injection on DCE (Dynamic Contrast Enhanced) acquisitions, suggesting the diagnosis of cavernous hemangioma (Figure 1).





Figure 1 Left orbital mass pointed out on coronal T2-WI Dixon series and on axial post-contrast T1-WI series (asterisk)

#### **Post-processing**

ADC and IVIM maps were computed and analyzed using Olea Sphere<sup>®</sup> software (Olea Medical<sup>®</sup>, La Ciotat, France). A multiparametric display (b0, b2000, T1 gado, ADC, D, D\*, PF) was used to draw regions of interest (ROIs) and to provide quantitative values of the mass metrics.

### **Diffusion-Weighted Images (DWI)**

The orbital mass was detected by a hyperintense signal on the axial b0 image and a large freehand ROI encompassing the largest area inside the lesion was placed and automatically propagated on all available maps. Apparent diffusion coefficient (ADC) map showed a high ADC value of 1.26 x 10<sup>-3</sup> mm<sup>2</sup>/s, confirming a probably benign lesion (Figure 2).

## Intravoxel incoherent motion (IVIM) imaging

The true diffusion coefficient (D), the pseudodiffusion coefficient (D\*) and the perfusion fraction (PF) maps also showed the left orbital mass with mean values of  $1.02 \times 10^{-3}$  mm<sup>2</sup>/s,  $14.6 \times 10^{-3}$  mm<sup>2</sup>/s and 0.18 respectively. In addition, voxels inside the lesion presented a bi-exponential behavior, confirming the presence of both diffusional and perfusional components of the IVIM imaging (Figure 3).



Figure 2 b0 image and ADC map

### **Histopathology diagnosis**

The biopsy confirmed the diagnosis of cavernous hemangioma which is the most frequent benign lesion in the orbit.



Figure 3 Left orbital mass pointed out on D, D\* and PF maps (asterisk) with bi-exponential fitting curves showing signal intensity as a function of b-values (red: raw data; blue: fitted data)



Figure 4 Multiparametric display with diffusion maps (ADC, b0, b2000, D, D\* and PF)

#### Conclusion

Diffusion-weighted imaging has been used in a variety of organs, with a few studies in the orbit. They showed that a restricted diffusion in orbital tumors during MR imaging with echo-planar DWI was associated with malignancy, especially in lymphoid lesions such as lymphoma [Ref. 1-3]. Moreover, the association of ADC with dynamic contrast-enhanced (DCE) perfusion helped to predict malignancy in another recent study [Ref. 4], with ADC alone yielding the optimal sensitivity in differentiating malignant from benign orbital lymphoproliferative disorders [Ref. 3]. Acquisition of IVIM parameters could potentially be useful in the characterization of orbital masses, since more quantitative DWI parameters are acquired, some of them reflecting tissue perfusion. It could also serve as a potential biomarker to evaluate therapeutic responses under treatment such as chemotherapy in lymphomas or proton therapy in ocular melanomas.

#### References

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