# ECHO-PLANAR VERSUS PROPELLER DIFFUSION-WEIGHTED IMAGING AT 3T FOR ASSESSMENT OF THYROID TUMORS

*S. Nagala[1], M. A. McLean[2], D. Scoffings[3], A. N. Priest[3], P. Jani[1], and J. R. Griffiths[2]*

***[1]Otolaryngology, Addenbrooke's Hospital, Cambridge, Cambridgeshire, United Kingdom, [2]Cancer Research UK, Cambridge Research Institute, United Kingdom, [3]Radiology, Addenbrooke's Hospital, Cambridge, United Kingdom***

***Introduction***

Recent studies have measured mean Apparent Diffusion Coefficients (ADCs) of thyroid tumors in an attempt to differentiate between malignant and benign tissue. All the studies used single-shot echo-planar diffusion-weighted imaging (DW-EPI) at 1.5 Tesla (1-4). Images of some patients could not be interpreted as a result of distortion. We hypothesized that DW-PROPELLER would improve interpretability of images in this region.

***Methods***

We pre-operatively imaged 12 patients (mean age 45.8, 10/12 female) with thyroid tumors and 5 thyroid glands in normal subjects (mean age 35, 4/5 female) using both DW-EPI and DW-PROPELLER on a 3Tesla Signa HDx scanner (GE Healthcare, Waukesha WI, USA). Signal was transmitted using the body coil and received using two channels of a four-channel phased array surface coil (PACC, Machnet BV, Elde, The Netherlands) designed for studies of the carotid arteries. One arm of the coil was centered over the region of interest to maximize local sensitivity and secured by a soft cervical collar to reduce motion artifact. For the DW-EPI, a dual-spin-echo sequence with the following imaging parameters were used: TE=81ms; TR=2200 ms; FOV 22 cm; matrix 128x128; 16 averages; slice thickness 5 mm; spacing 1 mm; b-values of 0 and 500 s/mm$^2$. Fat saturation was achieved using both a spectrally selective saturation pulse and a water-selective excitation pulse. Spatial saturation bands were also used to remove signal from overlying fat and other nearby tissues. The DW-PROPELLER sequence used the same geometry and TE=97 ms; TR=5000 ms; echo train length 16. A phantom with two vials, one with 20% gelatin and one with pure distilled water was imaged using both sequences with b-values of 500 and 1000 s/mm$^2$.

A consultant neuroradiologist with 5 years experience in interpreting head and neck MR was blinded to the clinical data of the subjects. Regions of interest (ROIs) were drawn using FuncTool software (GE Healthcare) around tumors in the patients and normal thyroid tissue in the controls. The interpretability of images was noted for both DW-EPI and DW-PROPELLER.

***Results and Discussion***

The DW-EPI sequence produced visibly more distorted images than the DW-PROPELLER sequence (example in Figure 1). This resulted in DW-PROPELLER being successfully interpreted (16/17 (94%) subjects) in significantly more subjects than DW-EPI (10/17 (59%) subjects). Table 1 summarizes the mean ADC values for the benign, malignant, and normal thyroid tissue and in the phantom. It shows that EPI was generally unsuccessful in the normal group. Since normal thyroid glands tend to have a smaller volume of tissue compared to thyroid tumors, shimming is more difficult and therefore distortion is more likely to result in uninterpretable images.

Similar mean ADC values were obtained in the phantom at both b values (Table 1). However, DW-PROPELLER mean ADCs were 7-20% higher than the DW-EPI. In vivo, ADCs were on average 43% higher with DW-PROPELLER than with DW-EPI. This is consistent with a recent report that DW-PROPELLER with fat saturation gives higher ADC than DW-EPI (5). The cause of this difference is unclear and needs further investigation before DW-PROPELLER can be recommended as a replacement for DW-EPI in the thyroid.

Due to the small sample size, statistical comparisons between tumor types were not carried out. However, benign tumors appeared to have greater mean ADCs than malignant tumors and these preliminary results show promise. .

***Conclusion***

DW-EPI produced distorted images of the thyroid, but the images were interpretable more often in tumors than in normal tissue. Distortion was reduced by using DW-PROPELLER at 3T, leading to interpretable images in nearly all tumors as well as in normal subjects. However, systematic differences appeared between the ADC values measured using DW-EPI and DW-PROPELLER and this issue must be resolved before a final recommendation can be made.

***References***

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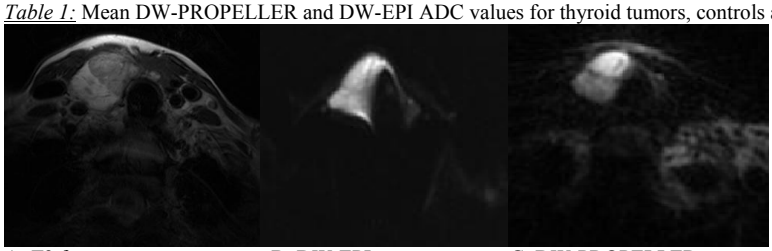
| | EPI interpreted | Mean ADC (x $10^{-3}$ mm$^2$/s) | PROPELLER interpreted | Mean ADC (x $10^{-3}$ mm$^2$/s) |
|---|---|---|---|---|
| **Benign (n=7)** | 5 | 2.32 | 6 | 3.17 |
| **Malignant (n=5)** | 4 | 1.80 | 5 | 3.01 |
| **Normal (n=5)** | 1 | 1.81 | 5 | 2.73 |
| **20% gelatin** | Yes | 1.21 (b=500), 1.28 (b=1000) | Yes | 1.45 (b=500), 1.37 (b=1000) |
| **Water** | Yes | 2.31 (b=500), 2.22 (b=1000) | Yes | 2.49 (b=500), 2.41 (b=1000) |

*Table 1:* Mean DW-PROPELLER and DW-EPI ADC values for thyroid tumors, controls and phantom



A: T2 fatsat B: DW-EPI C: DW-PROPELLER

*Figure 1:* Example of a patient with a benign thyroid nodule