DWI of head and neck cancer the effect of b values on ADC measurements

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Introduction: Diffusion weighted imaging (DWI) has recently been considered a potential tool for the investigation of head and neck cancer. This technique has been used both for the characterization of tumors and the monitoring of their treatment response after radiotherapy and chemotherapy[1-8]. Application of this technique relies on the measurement of the apparent diffusion coefficient (ADC) which is calculated from the DWI dataset. However, there is no generally agreed DWI protocol, including no agreement on the magnitude and number of b-values which should be used to obtain the ADC map. Whether differences in the magnitude and number of b-values have an effect on the ADC measurement is still unclear. The aim of this study was to examine the effect of b-values on ADC measurement of cancer in a group of patients with nasopharyngeal carcinoma (NPC).

Material and Methods: DWI was performed on 14 patients (mean age, 55 years; age range 39-80 years; 10 males, 4 females). They had histologically confirmed NPC and underwent MRI of the head and neck as part of their disease staging work-up. DWI was performed with institutional approval and informed consent. Imaging was performed on a 3.0T scanner (Achieva X-series, Philips Medical Systems) using a 16-channel head and neck coil. For each patient, same DWI sequence [TR/TE, 935/57 ms; section thickness/gap, 4/0 mm; FOV, 230 mm; matrix, 110 × 110 (256 × 256); NSA, 3; slice, 11] was applied twice using two sets of b- values (a) 0, 100, 200, 300, 400 and 500 s/mm^2; (b) 0, 200, 400, 600, 800 and 1000 s/mm^2. From the first DWI dataset in the lower b value range, ADC maps were calculated using two b-factors 0 and 500 (set A) and six b-factors 0, 100, 200, 300, 400, and 500 (set B). From the second DWI dataset in the higher b value range, ADC maps were calculated using two b-factors 0 and 1000 (set C) and six b-factors 0, 200, 400, 600, 800 and 1000 (set D). ROIs were drawn manually around the whole lesion of primary tumors (Fig. 1) and metastatic nodes. For primary and metastatic nodes the ADC values obtained in the lower b-value range were compared with those obtained from the higher b-value range, and also for each range the two b factor method was compared with the six b-factor method. Statistical analysis using non-parametric Mann-Whitney test was performed (Prism, GraphPad Software, Inc., San Diego, CA).

Results: ADC values from 14 primary tumors (mean diameter 2.5 cm) and the 29 metastatic nodes (mean diameter 2.4 cm) were measured. ADC results obtained from ADC maps calculated using different combinations of b-values are showed in Fig. 2. ADC values were significantly lower (12% lower) when ADC maps were derived from the higher maximum b-value (1000 vs. 500 s/mm^2) irrespective of whether DWI used a two b-factor (primary, $p = 0.005$; metastatic node, $p < 0.0001$) or a six b-factor calculation method (primary, $p = 0.001$; metastatic node, $p < 0.0001$). The ADC values showed no significant difference when using two b-factor or six b-factor calculation method for the same maximum b-factor 500 s/mm^2 (primary $p = 0.945$, metastatic nodes $p = 0.71$) or 1000 s/mm^2 (primary $p = 0.47$, metastatic nodes $p = 0.40$).

Discussion: Employing a lower range of b-factors (e.g. 500 s/mm^2) as a means of reducing susceptibility artifacts in neck produced significantly higher ADC values than when a higher range of b-factors were used (e.g. 1000 s/mm^2). This finding may be the result of perfusion effects which are known to be more pronounced when lower b-factors are used in DWI. Previous head and neck studies performed at 1.5T[1, 2] could not use parallel imaging to reduce susceptibility artifacts and so DWI often had to rely on using lower b-factors to reduce image distortion. In the present study, at 3T parallel imaging was employed and image distortion was not found to be a major problem. Therefore, employing a higher range of b-factors may be advantageous as perfusion effects become less pronounced. The results have shown also that using the two or six b-factor method did not yield significantly different results, but larger studies would be needed to confirm this result, especially in regions of the head and neck which are even more prone to the effects of motion. In conclusion, our results confirm that the choice of maximum b-factors has measurable effects on ADC results but the number of data points used in the calculation of ADC map does not appear to influence the ADC value.

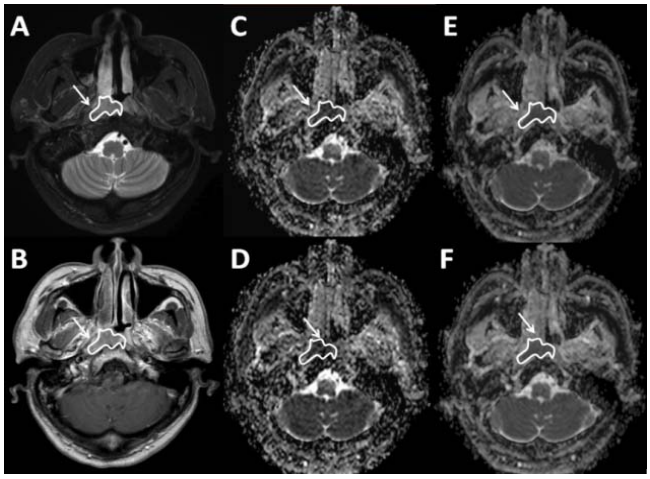

Figure 1 - A, T2 fat suppression weighted images; B, T1weighted with contrast images; C, two point ADC map (0 & 500) calculation ; D, six point ADC map (0, 100, 200, 300, 400, 500) calculation; E two point ADC map (0 & 1000) ; F, six point ADC map (0, 200, 400, 600, 800, 1000).

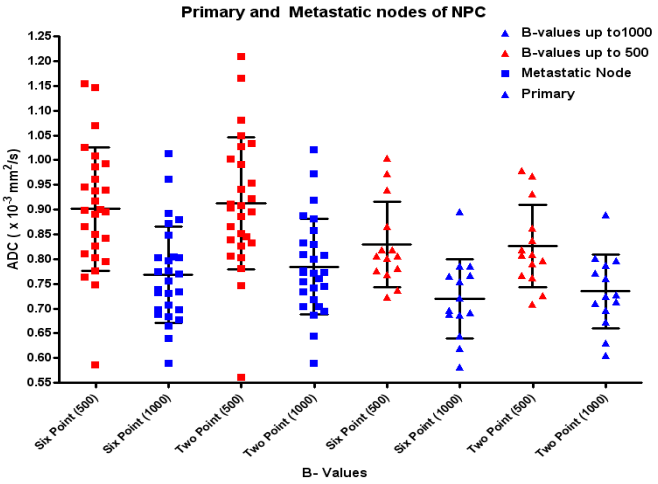

Figure 2 – Distribution of ADC values measured from ADC maps derived from different maximum b-factors (500, 1000 s/mm^2) and number of b-factors (2-point or 6-point fitting) from patients with NPC (primary and metastatic nodes).

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