Quantitative Measures of Glioma Edge Characteristics on Diffusion Weighted Images – Interobserver Agreement.

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Introduction: Multiple methods can be applied to conventional MRI images of glioma to aid diagnosis and differentiation of subtypes of glioma, these include descriptive measures of tumour size, signal characteristics and quantitative measures, such as the tumour border sharpness coefficient (TBSC)[1,2]. Diffusion-weighted imaging (DWI) sequences are very sensitive to diffusion restriction, and use the properties of water diffusion to approximate cellular density. Apparent Diffusion Coefficient (ADC) has been used to differentiate solid tumour form tumour associated oedema [3]. The ADC transition coefficient (ATC) of tumours is a measure proposed by Jenkinson *et al.* of the rate of change of cellular density over a tumour boundary on ADC images; it has been shown to differentiate 1p/19q status in gliomas [4]. The method does not accommodate for the presence or absence of oedema. We propose a simple clear method of analysing the tumour border sharpness of glioma on ADC maps which yields two distant border properties; ADC transition coefficient into oedema (ATCO) and ADC transition coefficient into tumour (ATCT) and aim to demonstrate their ease of use and reproducibility. This work aims to test the null hypothesis: neither ATCO nor ATCT are reproducible methods.

Methods: A retrospective analysis was performed on 23 patients (18-76 years, mean 58.7) with histologicaly proven grade IV gliomas. All imaging was performed prior to surgery at Salford Royal Hospital (Salford, UK) using a 3.0T Philips Achieva system, a SENSE Head Coil (Philips Medical Systems BV, Best, Netherlands) using DWEPI, TR=68ms TE=2312ms, b=0 and 1000 seconds/mm^2, FOV 230mmx230mm, thickness=4mm, interval=5mm and matrix 128x128. Independent analysis was performed by 2 radiologist (JRC and GT) using freeware analysis software Image J (NIH, Bethesda, Maryland, USA, http://rsb.info.nih.gov/ij/). Two border sharpness coefficients were generated for each ADC sequence the first was the border from normal brain white matter into the oedema surrounding the tumour (ATCO) the second was from the oedema into the solid tumour (ATCT). The measurement method was adapted from TBSC method proposed by Aghi *et al.*, and the ATC method proposed by Jenkinson *et al.* [1,5]. Images were converted to analyse format (128x128 matrix) and at representative image chosen showing the greatest transaxial tumour area. For the ATCO a 1x2 voxel ROI was created and placed as close as possible to the anterior edge of the area of ADC brightness (such that the greyscale units did not deviate from that of an ROI in the same location in the contra-lateral hemisphere) and the mean voxel greyscale measure was recorded. This was repeated for three more consecutive ROI's running into the tumour. The slope of linear regression was calculated. This was repeated for the medial, lateral and posterior tumour borders on the same slice (excluding edges which border ventricles, cortex, dura or skull vault). ATCO was calculated from the mean of these values. This process was repeated for ATCT measuring consecutive ROI's from the anterior inner edge of the oedema into the solid tumour, calculating the regression slope and again measuring available posterior, medal and lateral tumour borders and deriving a mean. Interobserver agreement was measured using Altman Bland analysis and interclass correlation coefficient (ICC).

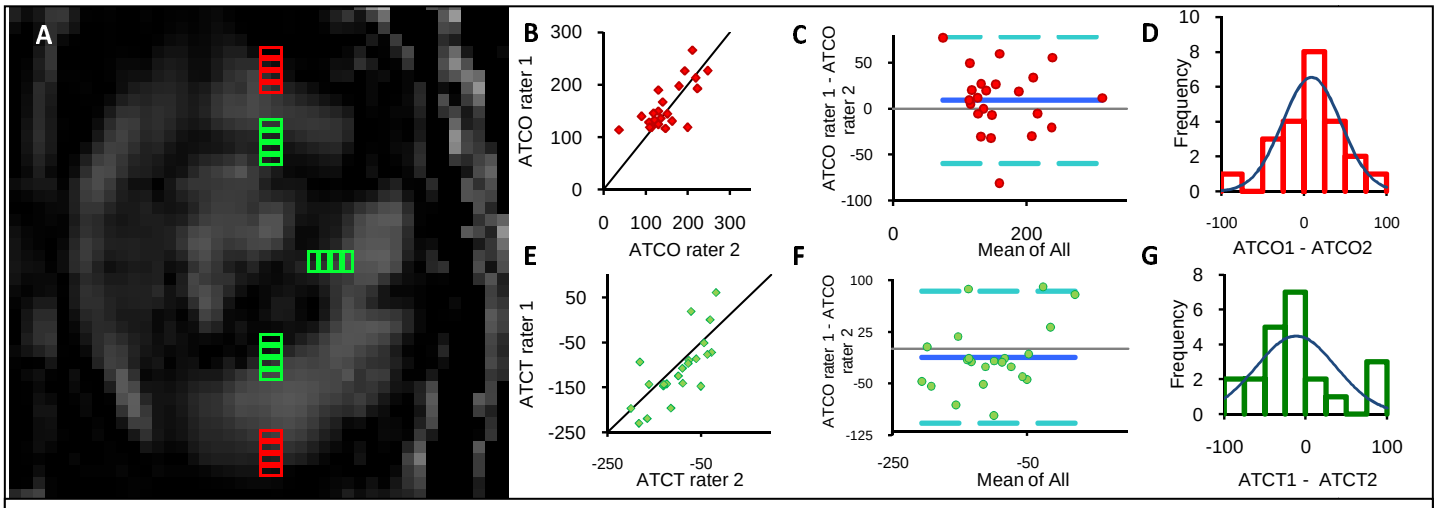

Figure 1: A) Method for calculating ATCO (red) and ATCT (green). B) Scatter plot of rater 1 v rater 2 ATCO. C) Altman Bland plot of differences between raters on ATCO. D) Histogram of differences between raters ATCO measurements. E) Scatter plot of rater 1 v rater 2 ATCT. F) Altman Bland plot of differences between raters on ATCO. G) Histogram of differences between raters ATCO measurements.

Results: Generation of ATCT and ATCO took less than 5 minutes per tumour. Excellent agreement was found for both ATCT and ATCO with no significant bias (Figure 1). The ATCO ICC type A = 0.895 (95% CI 0.753-0.955) the ATCT ICC type A = 0.834 (95% CI 0.600- 0.931).

Conclusion: This study has demonstrated excellent interobserver agreement of ATCO and ATCT. These two novel measurements represent a simple way of quantifying the rate of change of ADC signal across the interface between brain-oedema and oedema-tumour boundaries. They have the potential to be more valuable than the previously described ATC measure as they enable separate analysis of tumour and oedema tissue boundaries. These measures may therefore provide further information about the infiltrative nature of a tumour.

References:

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