Is Volume Transfer Coefficient (Ktrans) Related to Histological Grade in Human Gliomas?

A. Jackson[1], T. Patankar[1], H. Haroon[1], S. Mills[1], D. Buckley[2], G. Parker[1]

[1]Imaging Science, University of Manchester, Manchester, Greater Manchester, United Kingdom, [2]Imaging Science, University of Manchester, Manchester, Lancashire, United Kingdom

INTRODUCTION: Dynamic acquisition of images during contrast enhancement allows calculation of specific descriptive parameters related to local microvasculature characteristics including cerebral blood volume (CBV). Many groups have demonstrated a relationship between CBV and tumour grade. Measurements of contrast transfer coefficient (K^{trans}) reflect local blood flow and endothelial permeability surface area product and might therefore be expected to provide additional information This has led several authors to examine the relationship between the transfer coefficient and tumour grade[1-4]. However, the results from these studies have been conflicting. This study represents an attempt to clarify the potential value of CBV and K^{trans} measurements for classification of cerebral gliomas using a well-validated pharmacokinetic modelling technique

MATERIALS AND METHODS: Thirty-nine patients with clinically suspected gliomas of varying grades were recruited for this study (mean age of 52.9 years (range: 31–77 years), 29 males and 10 females). All diagnoses were histologically confirmed. Imaging was performed on two identical 1.5 Tesla MR systems. Three pre-contrast data sets were acquired for baseline T1 calculation using a 3D T1-FFE (T1 fast field echo) sequence (TR/TE 4.2/1.2 ms, field of view 230 × 230 mm, imaging matrix 128 × 128, slice thickness 6 mm interpolated to 3 mm, 25 slices) with flip angles of 2°, 10° and 35°. This was followed by a dynamic contrast-enhanced acquisition series at a flip angle of 35°, consisting of 20 volume acquisitions with a temporal spacing of approximately 5 seconds. Gadolinium-based contrast agent (Gd-DTPA-BMA; Omniscan™, Amersham Health AS, Oslo, Norway) was injected as a bolus over 4 seconds at a dose of 0.1 mmol/kg of body weight following acquisition of the ninth image volume. Pixel by pixel values of K^{trans} and CBV were calculated using the theoretical approach described by Li et al [5]. Median and 95th centile values of these variables were derived from regions of interest containing all enhancing tissue.

RESULTS: There were significant differences between high and low grade tumours for all four parametric variables (K^{trans}, K^{trans} (95%), CBV and CBV(95%); $p < 0.001$). Logistic regression analysis showed K^{trans} (95%) and CBV to be independently and significantly related to grade ($p < 0.01$ and $p < 0.05$, respectively). Analysis based on all grades showed significant group differences between tumour grades for all four parametric variables (K^{trans}, K^{trans} (95%), CBV and CBV(95%); $p < 0.001$). Pairwise comparisons demonstrated significant differences between grades II and III and between grades II and IV for all variables except K^{trans}, which did not show significance in the grade II and III comparison, and between grades III and IV for CBV and CBV(95%). There was a significant correlation between grade and the median values of each of the parametric variables ($p < 0.01$). The correlation was greatest for K^{trans} (95%) ($r = 0.740$, Table 4). Discriminate analysis identified a single significant predictive function $C1 = 0.695 \cdot (CBV) + 0.577 \cdot (K^{trans}\ (95\%))$. Values of K^{trans} and CBV(95%) had no independent predictive value.

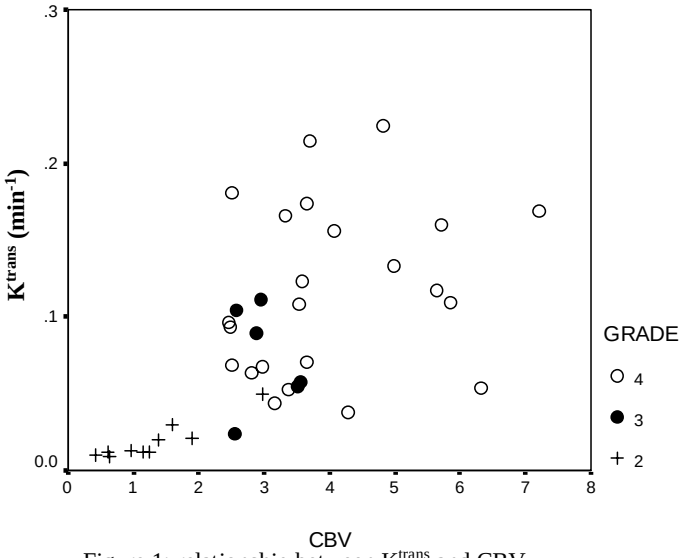

Figure 1: relationship between K^{trans} and CBV

CONCLUSIONS: We have demonstrated strong relationships between both CBV and Ktrans and histological grade in gliomas. Either measurement, or a combination of the two, show good discriminative power in distinguishing between low and high grade tumours with diagnostic sensitivity and specificity in excess of 90%. The identification of grade III and grade IV tumours is relatively poor with diagnostic sensitivity of only 68% and specificity of 62%.

REFERENCES

1.Law, M., et al., AJNR Am J Neuroradiol, 2004. 25(5): p. 746-55.
2.Ludemann, L., et al., Eur Radiol, 2001. 11(7): p. 1231-41.
3.Provenzale, J.M., et al., AJR Am J Roentgenol, 2002. 178(3): p. 711-6.
4.Roberts, H.C., et al., AJNR Am J Neuroradiol, 2000. 21(5): p. 891-9.
5.Li, K.L. and A. Jackson,. Magn Reson Med, 2003. 50(6): p. 1286-95.