Purpose: Dynamic Contrast Enhanced Magnetic Resonance Imaging (DCE-MRI) has shown prognostic potential in glioblastoma multiforme (GBM). Enhancing Fraction (EnF) is a recently described DCE-MRI derived measure [1-3]. This quantifies the proportion of a tumour that enhances and in GBM has been shown to correlate with \( K^{trans} \) (contrast agent transfer coefficient) derived from DCE-MRI [3]. The objective of this study was to evaluate the prognostic value of EnF in GBM.

Materials and Methods: 15 patients with GBM were recruited. All underwent standard radiotherapy with adjuvant & concomitant temo-zolamide. All imaging was performed prior to surgery on a 3 tesla MR scanner. Imaging included \( T_1 \)-weighted DCE-MRI (3 pre-contrast spoiled fast field echo sequences with different flip angles (\( 2^\circ, 10^\circ, 16^\circ \)) for calculation of baseline \( T_1 \) maps (TR 3.5ms, TE 1.1ms, slice thickness 4.2mm, 128x128) and a dynamic, contrast enhanced acquisition series with identical acquisition parameters as the variable flip angle baseline \( T_1 \) measurement, consisting of 100 volumes with temporal spacing of approximately 3.4 seconds, with gadolinium-based contrast agent injected as a bolus of 3ml at 15 ml/s, at a dose of 0.1mmolkg\(^{-1}\) of body weight after acquisition of the fifth image volume) and anatomical sequences (pre and post contrast geometrically matched \( T_1 \) weighted images, TR 9.3 ms, TE 4.6 ms, slice thickness 4.2mm, 128x128). Voxels were classified as enhancing if the initial area under the contrast concentration curve (IAUC) was positive (EnF\( \text{IAUC}_{60}>0 \)). A threshold of IAUC\( > 2.5 \text{ mMol.s}^{-1} \) was used to generate thresholded EnF (EnF\( \text{IAUC}_{60}>2.5 \)). Parametric maps of IAUC\( _{60} \), \( K^{trans} \), \( v_p \) (blood plasma volume per unit volume tissue), and \( v_e \) (volume of the extravascular extracellular space per unit volume tissue) were generated. The prognostic value of patient age, sex, tumour volume, EnF\( \text{IAUC}_{60}>0 \), EnF\( \text{IAUC}_{60}>2.5 \), median IAUC\( _{60} \), median \( K^{trans} \), median \( v_p \), and median \( v_e \) were assessed using a multivariate Cox regression analysis.

Results: Examination of survival data from deceased patients demonstrated a linear relationship between EnF\( \text{IAUC}_{60}>0 \) and patient survival (p<0.05, \( R^2=0.525 \), Figure 1). Only EnF\( \text{IAUC}_{60}>0 \) was identified as an independent prognostic factor (p<0.05). Illustrative patient examples are shown in Figure 2.

Conclusion: This preliminary study suggests a possible relationship between EnF and length of survival in patients with GBM. We hypothesised that this relationship reflects the effect of increasing intracranial pressure in the face of failing physiological compensation mechanisms, resulting in a fall in enhancing proportion.

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References: