Multi-parametric Composite Maps in Recurrent Brain Tumor Patients

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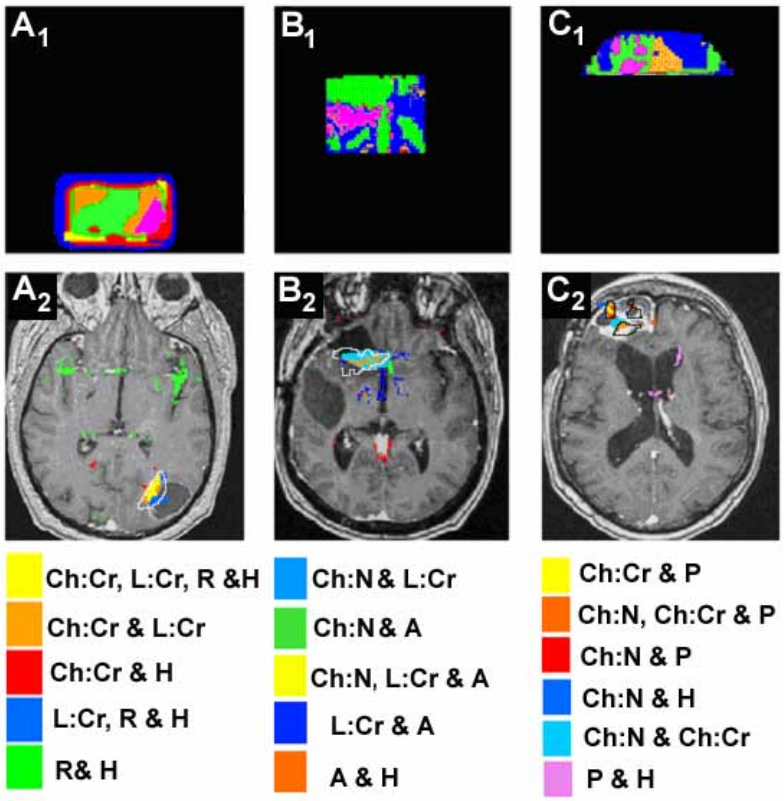
Introduction

Glioblastoma multiforme (GBM) patients often recur locally, and the median survival has remained 50 weeks for several decades (1). If diagnosis of recurrence can be made quickly, with a high degree of confidence, treatment can be quickly initiated. Physiologic parameters are thought to add information regarding tumor composition and extent, and could have utility in diagnosis. CSI, perfusion, diffusion and hypoxia mapping were added to the MRI follow-up protocol for treated GBM in three patients. When considering how many and which maps to use when mapping recurrent areas, voxels considered abnormal by multiple techniques are of particular interest. By considering an extreme percentage of each physiologic parameter and calculating percent overlaps, we were able to determine the number and identity of parameters that should be considered further.

Materials & Methods

All patients had previously been treated for GBM with resection and radiotherapy. Follow-up protocols were acquired at times ranging from six months to two years post external beam radiation therapy, depending on the patient. Imaging was performed at 1.5T (GE Signa). BOLD hypoxia mapping was based on the protocol described by Dunn et al (2). A standard 2D CSI protocol was utilized to obtain spectroscopy data (3). Likewise, relative cerebral blood volume (rCBV), permeability and apparent diffusion coefficient (ADC) maps were obtained using standard contrast-enhanced perfusion and diffusion weighted imaging (4). Maps were thresholded so that only an extreme percentage of values were displayed, then assigned unique values. Unions were calculated to form overlap composite maps. ISODATA (5) was performed using Eigentool software.



Results

Figure 1. Multiparametric Analysis of 3 Patients. Three patients (A,B,C) with biopsy-confirmed GBM recurrence after initial treatment are shown. ISODATA results in the CSI acquisition region are located in the top row. The pink clusters seem to indicate regions of recurrent disease. The corresponding composite maps formed by the overlap technique are located in the second row. The outlines (in white for A2 and B2 and black for C2) are from the pink ISODATA clusters. When threshold percentages are manipulated (A2: 9.4%, B2: 15.9%, C2: 5.4%), regions similar in size and location are found by both techniques. The colorbars located below the overlap map define which thresholded parameter maps overlapped in the colored regions. Ch:Cr = Choline:Creatine; L:Cr = Lactate:Creatine, Ch:N = Choline:NAA, A = ADC, R = rCBV, P = permeability, H = hypoxia.

Discussion

An technique of choosing appropriate parameters in post-therapy patients is important. The parameters are thought to indicate the following measures: ADC - cellularity; rCBV - quality of perfusion; CSI - metabolic changes of interest; Permeability – angiogenesis. Our hypothesis is that voxels in recurring areas will show changes in more than one physiologic parameter. While further insight is clearly necessary to define appropriate thresholds and isolate the most important techniques, we feel this work in forming composite maps is an important step in translating multi-parametric studies into the clinical environment.

References

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