MR Perfusion Imaging and Intensity- Time Curve Analysis in Cerebral Tumors

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Introduction: Perfusion weighted MR imaging is being extensively used for characterization of cerebral neoplasms and relative cerebral blood volume (rCBV) maps have been correlated with tumor vascularity. However there can be various factors affecting these maps in addition to the T2* signal reduction like the T1 and T2 * effects due to interstitial leakage of contrast. Information obtained from intensity- time curve (ITC) generated from the perfusion data may be valuable in determining these effects and hence further characterizing brain tumors [1].

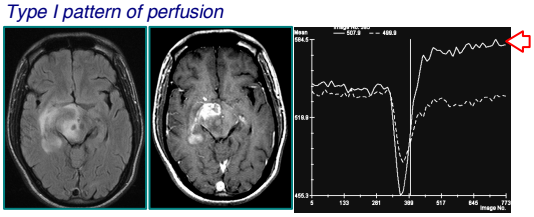
Aim: To study the potential usefulness of ITC in addition to the routine rCBV maps in characterizing cerebral neoplasms.

Materials and Methods: 14 patients (9 males and 5 females, mean age 49 yrs) were studied using dynamic contrast enhanced MR perfusion scans (TR/ TE/ FA/ SL=467/ 11mS/ 90^0/ 19) in addition to routine imaging on a 1.5 T clinical scanner (Avanto- SQ engine, Siemens, Erlangen, Germany). Meglumine Gadoterate in a dose of 0.1mmols kg^{-1} was injected in the left antecubital vein using 18G cannula with a power injector followed by saline flush in all the cases. The perfusion data were analyzed on a Leonardo workstation using the vendor provided software. In addition to rCBV maps, ITC were also plotted on the tumor as well as on the contralateral normal looking white matter. The results were compared with histopathology in all the cases.

Results: Four patterns of perfusion maps and curves were observed: (I) A relatively low rCBV of the lesion with a characteristic signal overshoot above the base line after the first pass of contrast seen on ITC (cases 1, 2). This pattern was seen in 3 cases of primary CNS lymphoma and one case of methotrexate induced severe demyelination. (II) A low rCBV with flat signal after the first pass was seen in two low-grade fibrillary astrocytomas (case 3). (III) A relatively high rCBV with a signal upshoot after the dip, but which never reached the baseline was seen in one glioblastoma with necrosis, mural nodules of a ganglioglioma and a pilocytic astrocytoma and 3 meningiomas (case 4), in addition to a metastasis. (IV) A high rCBV with a flat signal after the first pass was seen in a case of high-grade glioma without necrosis (case 5). The signal intensity in lesions after the first pass of contrast is depended on various factors. These include the relaxivity mechanisms due to contrast leakage into the interstitium in addition the technical parameters used. The resultant signal intensity is largely determined by the relative contribution of T2* within the intravascular and interstitial compartments and the T1 effects (1). Various cerebral tumors may show different degrees and types of 'leak' and this information can be coupled with the capillary density measurements (rCBV) in further characterizing brain tumors.

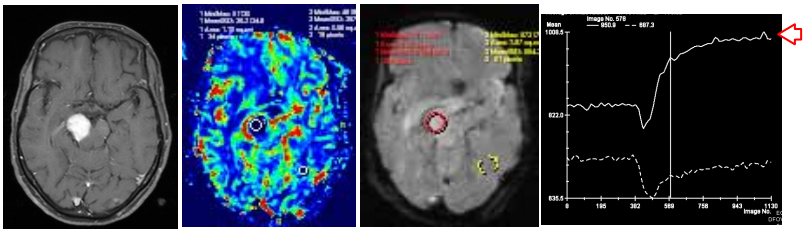
Conclusion: Information available from the ITC can be coupled with the rCBV maps in the characterization of cerebral tumors. Some of the relatively benign lesions also can mimic tumors. Further larger studies are required to validate these findings.

***Case 1**: 39 old man with primary CNS Lymphoma- Note the characteristic Intensity- time curve with delayed upstroke above the base (red arrow) – Type I pattern of perfusion*



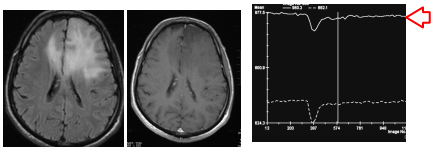
FLAIR T2 CE T1 ITC

Case 2: 52 year old woman with methotrexate induced severe demyelination of the brain stem. Radiological DD is lymphoma, Note the type I pattern of perfusion



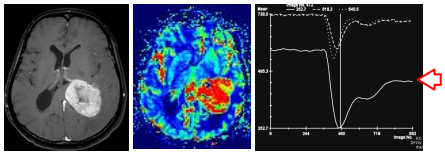
CE T1 rCBV map ITC ROI ITC

***Case 3**: Left frontal diffuse fibrillary astrocytoma. Note the Type II pattern of perfusion.*



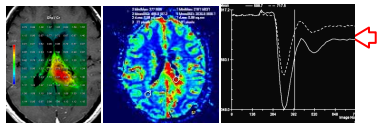
FLAIR CE T1 ITC

***Case 4:**Intraventricular meningioma Type III pattern of perfusion*



CET1 rCBV ITC

***Case 5:** Type IV pattern, in a high-grade glioma without necrosis*



CSI: Cho/Cr rCBV ITC

Reference: 1. Hartmann M, Heiland S, Harting I, Tronnier VM, Sommer C, Ludwig R, Sartor K. Distinguishing of primary cerebral lymphoma from high-grade glioma with perfusion-weighted magnetic resonance imaging.Neurosci Lett. 2003; 27; 338:119-22.

2. Rollin N, Guyotat J, Streichenberger N, Honnorat J, Tran Minh VA, Cotton F. Clinical relevance of diffusion and perfusion magnetic resonance imaging inassessing intra-axial brain tumors. Neuroradiology. 2006;48:150-9.