Supplementary Materials 2

Image Postprocessing

Conventional MR images, including axial T2 fluid attenuated inversion recovery (FLAIR) and postcontrast 3D T1-magnetization-prepared rapid gradient echo (MPRAGE) sequences for structural imaging, as well as DCE and DSC MR images were obtained from the PACS and digitally transmitted to a personal computer for analyses using a dedicated software package (Nordic ICE; Nordic Neuro Lab).

DCE MR Image Analysis

DCE MR imaging analysis was performed using the extended Tofts-Kermode pharmacokinetic model to compute permeability parameters, including Ktrans, Ve, and Vp, displayed as parametric maps [1].

First, we determined the threshold to establish the noise level while deriving the parameters from the DCE MR images. Second, the MR images were motion-corrected. Third, vascular deconvolution with the arterial input function (AIF) was semiautomatically performed by two investigators (with 6 and 16 years of experience in brain MRI, respectively) blinded to the prognosis information. In consensus, we manually located the region of interest for AIF in the major intracranial arteries, including the cavernous segment of the right or left internal carotid artery that produced the best-fitting AIF curve and the concentration-time curve. The baseline T1 was fixed at 1000 ms in this study to achieve more reliable data [2]. Finally, we overlaid (coregistered) the structural images (CE T1WI and FLAIR) and permeability maps (Ktrans, Ve, and Vp) from DCE MRI using an automatic algorithm that determined the most appropriate geometric transformation [3,4].

DSC MR Image Analysis

The normalized relative cerebral blood volume (nCBV) map was acquired using a dedicated software package that used an established tracer kinetic model on the first-pass data [5,6].

First, the images were realigned to minimize the effects of patient motion during the dynamic scans. A gamma-variate function that approximated the first-pass response as it would appear in the absence of recirculation was used to align the 1/T2* curves and diminish the effects of recirculation. To decrease the contrast agent leakage effects, the dynamic curves were modified mathematically [7]. After removing the effects of recirculation and contrast agent leakage, the relative cerebral blood volume (rCBV) was calculated by numerically integrating the curve. To minimize variances in the leakage-corrected rCBV of an individual patient, the pixel-based rCBV maps were normalized by dividing every rCBV value in a specific slice by the rCBV value in the unaffected white matter [8].

REFERENCES

1. Tofts PS, Kermode AG. Measurement of the blood-brain barrier permeability and leakage space using dynamic MR imaging. 1. Fundamental concepts. *Magn Reson Med* 1991;17:357-367
2. Haacke EM, Filleti CL, Gattu R, Ciulla C, Al-Bashir A, Suryanarayanan K, et al. New algorithm for quantifying vascular changes in dynamic contrast-enhanced MRI independent of absolute T1 values. *Magn Reson Med* 2007;58:463-472
3. Sundar H, Shen D, Biros G, Xu C, Davatzikos C. Robust computation of mutual information using spatially adaptive meshes. *Med Image Comput Comput Assist Interv* 2007;10:950-958
4. Pluim JP, Maintz JB, Viergever MA. Mutual-information-based registration of medical images: a survey. *IEEE Trans Med Imaging* 2003;22:986-1004
5. Rosen BR, Belliveau JW, Vevea JM, Brady TJ. Perfusion imaging with NMR contrast agents. *Magn Reson Med* 1990;14:249-265
6. Ostergaard L, Sorensen AG, Kwong KK, Weisskoff RM, Gyldensted C, Rosen BR. High resolution measurement of cerebral blood flow using intravascular tracer bolus passages. Part II: experimental comparison and preliminary results. *Magn Reson Med* 1996;36:726-736
7. Boxerman JL, Schmainda KM, Weisskoff RM. Relative cerebral blood volume maps corrected for contrast agent extravasation significantly correlate with glioma tumor grade, whereas uncorrected maps do not. *AJNR Am J Neuroradiol* 2006;27:859-867
8. Wetzel SG, Cha S, Johnson G, Lee P, Law M, Kasow DL, et al. Relative cerebral blood volume measurements in intracranial mass lesions: interobserver and intraobserver reproducibility study. *Radiology* 2002;224:797-803