Micro-hemorrhage Assessment on ADNI-GO/2 T2*-Weighted Images

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Summary

T2* weighted images are sensitive to the presence residue from micro-hemorrhages and superficial sideroses. Images are not specific and artifacts confound automated detection methods. Grading of these images in ADNI-2 data is done by manual raters using software designed to facilitate capturing the raters' assessments in a longitudinal framework.

Method

In the MRI protocol for ADNI-GO and ADNI-2 a long echo time gradient echo (T2*-weighted) image is acquired. This sensitizes the image to the effects of local iron deposits. Hence, small micro-hemorrhages (MCH) show up as small dark areas in the images. The are acquired as 3mm thick axial images with approximately 1mm in-plane resolution.

The assessment of images for the presence of MCH is carried out in the space of each available T2*-weighted image. Let there be N available T2* weighted images for a given subject. Label the scans N_i where i=1 to N MCH evaluation on the i-th scan is done in the coordinate system of the i-th scan using the origin and pixel location information provided by the MRI scanner. We use the term "finding" to refer to some point of medical interest in a T2* image. Findings are identified as MCH, superficial sidersosis, and a catch all "other" class. All findings are captured as a series of "observations". Each observation contains the location or set of representative locations. Findings observed on the i-th scan are in the coordinate system of the i-th scan. For display purposes the i-th scan is upsampled in-plane to 768x768 pixels viewed on a 1600x1200 monitor at 72 DPI. No through plane resampling is done on the i-th T2* image. We refer to this as the "display space". At risk of stating the obvious, a finding may have multiple

observations on multiple images and the locations of finding in each observation may shift with patient position. Observation locations are not reported in display space.

The N-1 other T2* scans are affine-registered to the i-th scan and resampled into the i-th scans display space. The locations of observations on the N-1 other T2* scans transformed into the coordinate system of the i-th scan using the appropriate affine transformation matrix. Transformed findings from the j-th scan are drawn on top of the transformed version of the j-th image. It should be noted that due to the relatively thick slices in the T2* images through plane interpolation effects may be significant. Findings are only assessed on the i-th image; findings on the N-1 other images are used for comparison purposes only and cannot be modified.

In the ADNI studies each T2* image has at least one good quality T1-weighted image. For each T1 image tissue probability maps are generated using SPM5 and into that image a 35-region atlas is propagated. A T1 image (typically from the same MRI study as the i-th T2* image) is affine registered to the i-th T2* image and resampled into the display space. The atlas is resampled using nearest neighbor interpolation. The probability maps are resampled using tri-linear interpolation and the T1 image is resampled using cubic-spline interpolation. Thus tissue probability estimates and atlas region assignments are automatically available for any findings subsequently identified on the i-th T2* image. The 35 region atlas is heavily dilated to insure that no gaps occur inside the head. This is under the assumption that the manual placement of finding markers on the image will preclude errors such as placing a finding inside the lateral ventricles.

All images intensities are linearly scaled so that pixels in white-matter are consistent intensity. Intensities can be manually adjusted for each image, although in practice it is found that this is necessary on less 1 in 1,000 images.

Operationally, the i-th image is selected and all the aforementioned registrations and resampling steps are done. A list of previously observed findings is presented. A trained analyst or radiologist then steps through the i-th image as a first pass to look for anomalies. All images are synchronized so previously observed findings are shown on their parent images. An finding can be "brought into" the i-th image by clicking on it in an image where it was observed and selecting "bring forward". This adds a record that the finding has now been observed in the i-th image. The record for the observation of the finding can be adjusted to reflect the observer's interpretation of the finding from the i-th image. The location(s) for the observation in the i-th image coordinate system can be adjusted if desired. This is allowed to compensate for small mis-registrations; it is seldom necessary.

The end product is a list of findings. For each finding there is a list of one or more observations. At each observation the finding's location in the image on which the observation was made is recorded as well as the status of the finding, an estimate of tissue probabilities at the finding location, and an atlas region assignment. The status of the finding takes one of three values: possible, definite, rescinded. Depending on the image on which the observation is made, the status may change. For example, a MCH finding considered possible on one image may be

rescinded if it is clear on review of a subsequent image that it was due to image artifact. Or a finding may be promoted to "definite" status if it appears on multiple images. Regional assignments can also be modified, although in practice this it is found that observers do this on less than 1 in 1,000 images.

In summary, T2* images are assessed. Relevant findings are cataloged with information about each observation of the finding on the associated T2* image. The positions of the finding are always stored in the MRI scanner coordinate system of the T2* image on which the observation was made.

Version Information

Version 1.0 is the initial version.

Dataset Name	Date Submitted
Jack Lab – DMN RV-ratio Version 1.0	7 December 2012

About the Authors

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