

# IMPROVED FREESURFER PARCELLATION OF STRUCTURAL MRI IN VCI POPULATION WITH INCLUSION OF MASKS FOR INFARCTS AND WHITE MATTER HYPERINTENSITIES

## BACKGROUND

- Current software packages in brain imaging have allowed researchers to examine changes in brain structures in vascular cognitive impairment (VCI) patients [1].
- The presence of small vessel disease and cortical infarcts pose a challenge in imaging analysis tools as they tend to increase misclassification errors [2].
- FreeSurfer (FS) is a neuroimaging tool used for parcellation and analysis of cortical and subcortical brain MRI. FS method not only depends on the intensities and probabilities of a voxel belonging to a given region, but also depends on the reliability of the neighboring voxels [3]. This dependency may account for the segmentation failures in the presence of large infarcts and significant white matter hyperintensities (WMH) commonly observed on MRI of VCI patients.

## PURPOSE & HYPOTHESIS

- **Purpose:** To reduce FS segmentation failures in a VCI cohort, by integrating lesion and skull-stripped brain masks from our in-house software called Semi-automated Brain Extraction + Lesion Explorer (SABRE+LE) Tool [4].
- **Hypothesis:** The SABRE+LE masks will improve the overall brain parcellation and segmentation in FS.

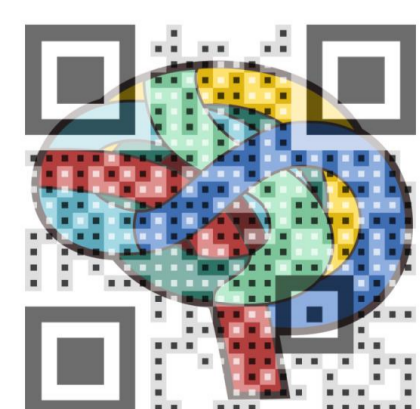
## METHODS

- 155 VCI patients underwent MRI as part of the Ontario Neurodegenerative Disease Research Initiative (ONDRI) study. ONDRI is a provincial collaboration studying dementia and how to improve diagnosis and treatment of neurodegenerative diseases (<http://ondri.ca/>).
- MRI imaging was acquired on 3T GE, Philips, and Siemens scanners.

## IMAGE PROCESSING

- FS outputs (skull stripped T1, cortical and subcortical segmentations) were visually evaluated before and after modifications.

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## IMAGE PROCESSING CONT'D

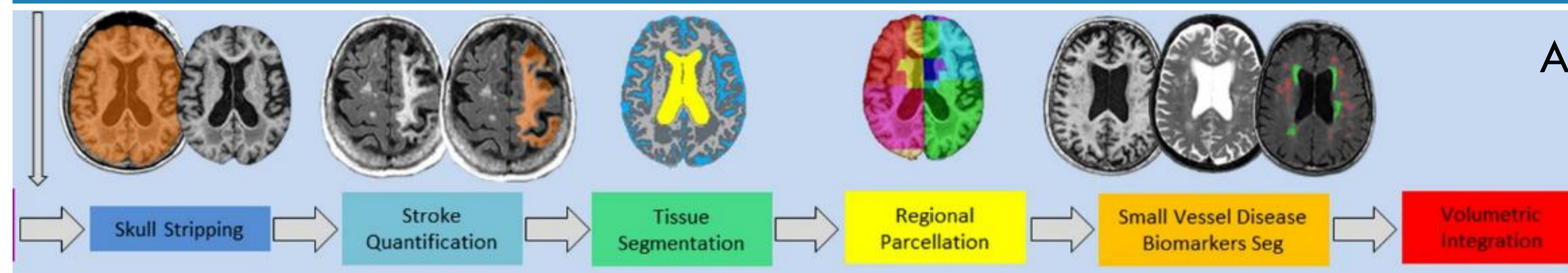


Figure A. Semi-automated Brain Extraction + Lesion Explorer Tool (SABRE + LE) used for tissue segmentation, White matter hyperintensities (WMH), and stroke quantification.

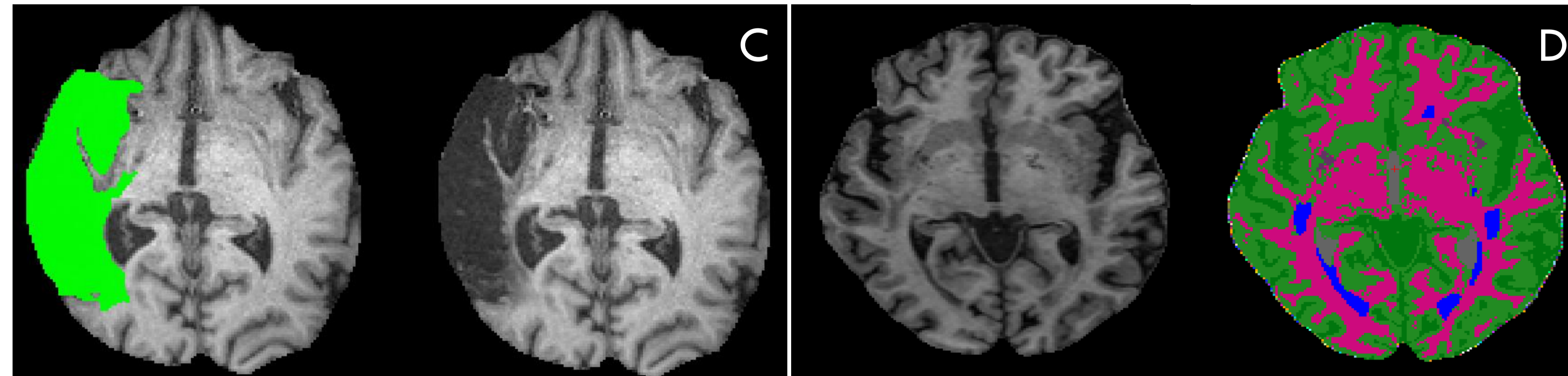


Figure C. Manually traced cortical infarct mask overlaid on T1 slice (left). Stroke lesion was traced on T1 and co-registered Fluid attenuation inversion recovery (FLAIR) images. Figure D. Skull-Stripped T1 image (left) and segmentation (including white matter hyperintensities and stroke lesions (right)) from SABRE+LE were integrated into FS.

## RESULTS

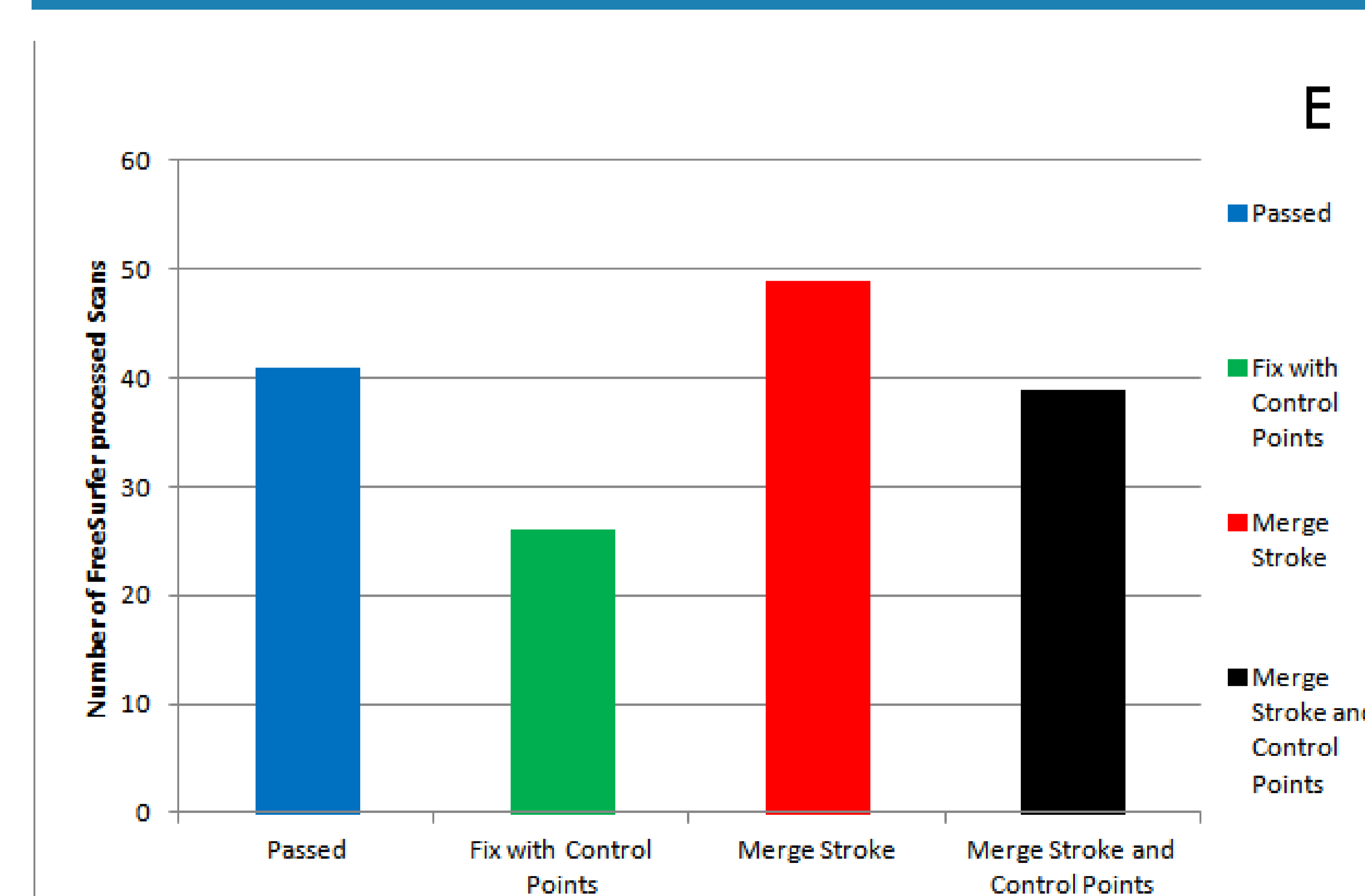


Figure E. 73.5% (114/155) failed using FS alone at first pass due to intensity normalization errors and cortical stroke. Out of the 114 failures at first pass, 26 needed intensity correction using auto control points, 49 strokes were to be filled, and 39 scans needed auto control points and infarct filling.

### References:

- [1] Brodtmann, A., et al. (2012). *Journal of the neurological sciences*.
- [2] Kabir, Y., et al. (2007, August). In *Engineering in Medicine and Biology Society, 2007. EMBS 2007*.
- [3] Fischl, B., et al. (2002). *Neuron*.
- [4] Ramirez, J., et al. (2011). *Neuroimage*.

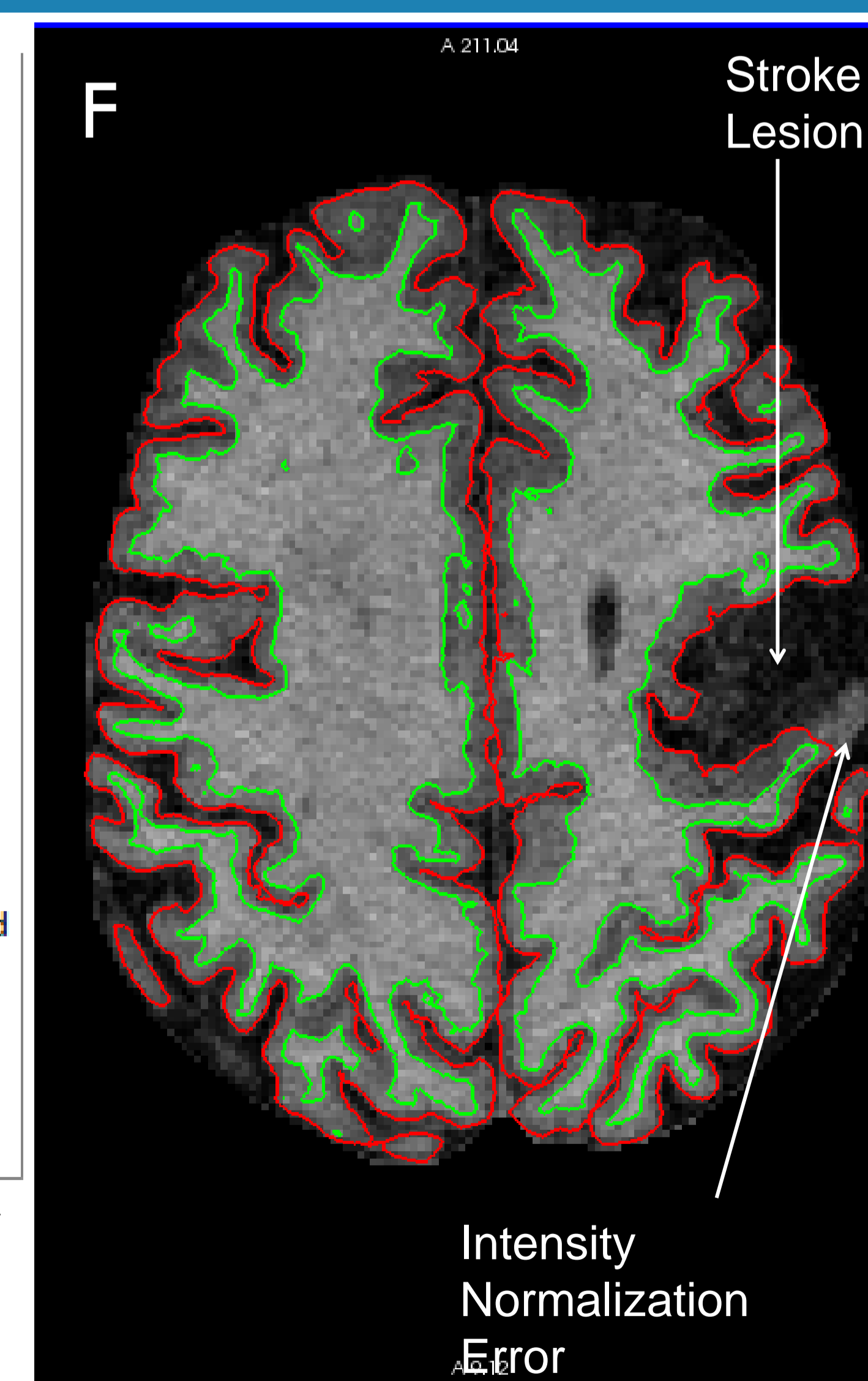


Figure F. Tissue segmentation failure in FS as a result of left infarct and Intensity normalization error before modification. Green colour = white surface. Red colour = pial surface.

## Processing Stream Overview

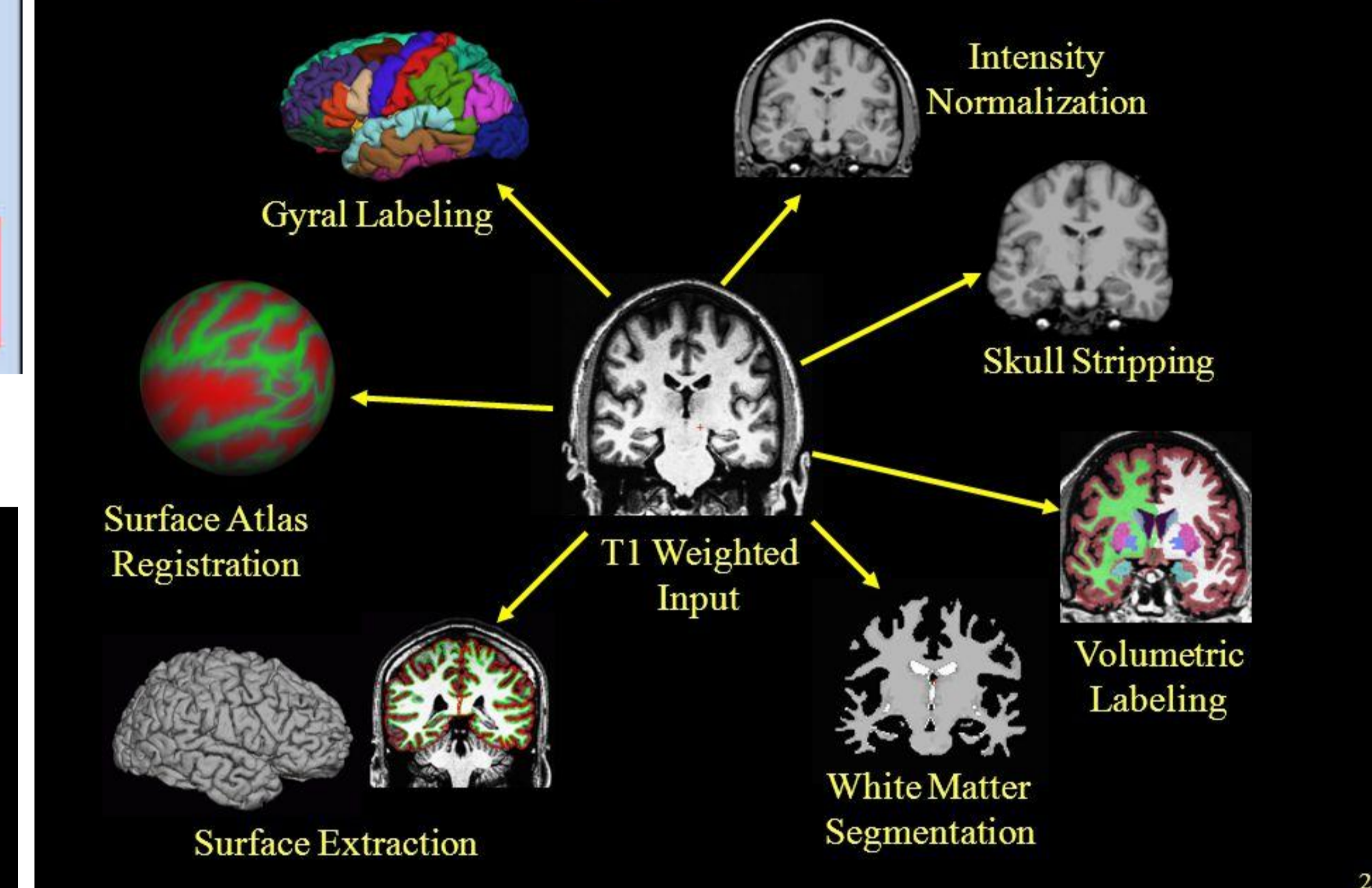


Figure B. Overview of FreeSurfer processing pipeline. 3DT1-based sequence was processed using FS v6.0 from (<http://surfer.nmr.mgh.harvard.edu/>).

## RESULTS CONT'D

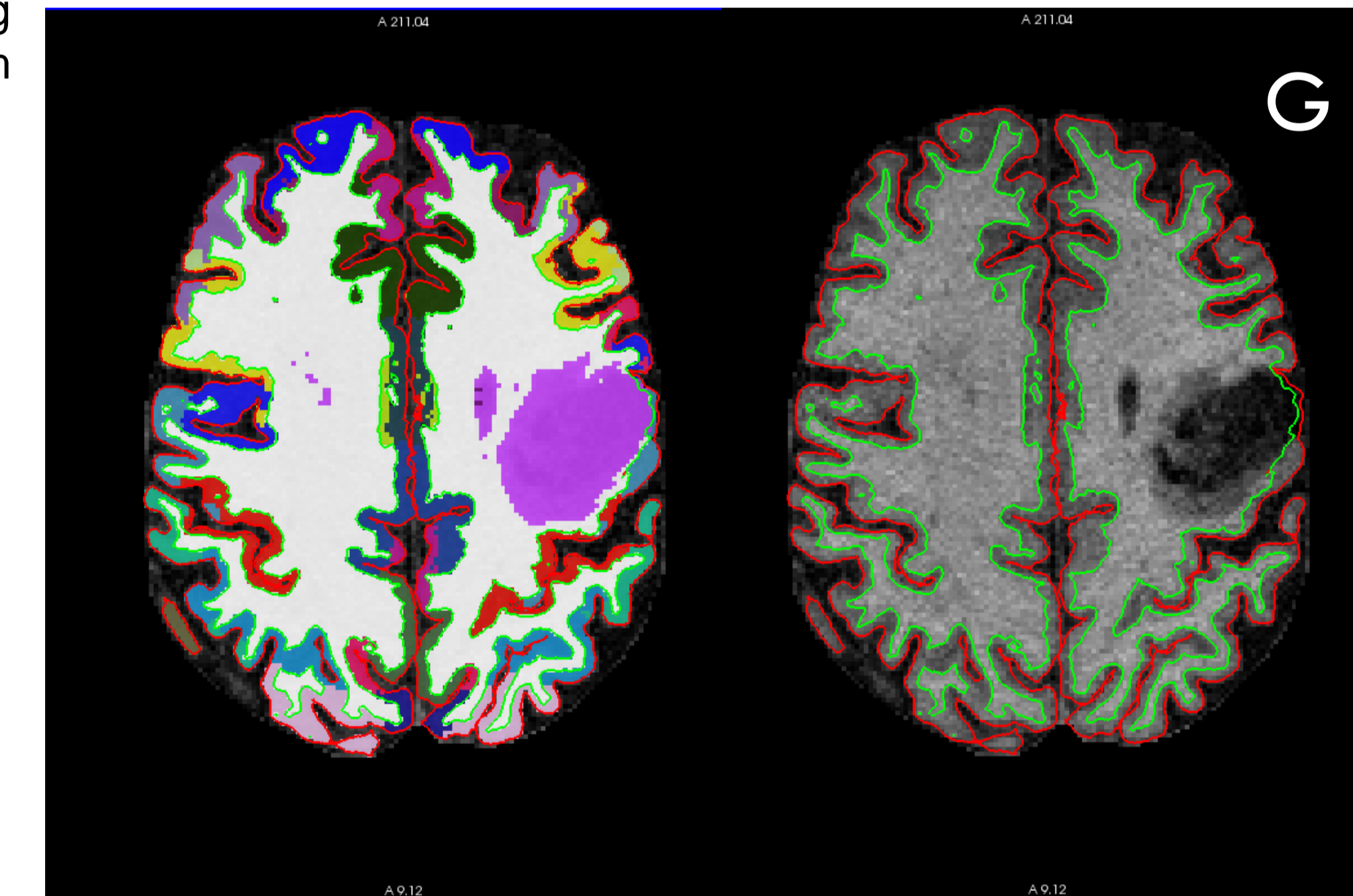


Figure G represents FS brain of VCI patient with large left hemisphere stroke. The inclusion of infarct mask and auto control points improved the overall brain parcellation in 76% (87/114) of failed FS scans.

## CONCLUSION

- Our findings suggest that accounting for infarcts and WMH might serve as a possible solution for researchers who may encounter similar issues that arise when examining VCI populations using FS.

## ACKNOWLEDGEMENTS

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