Brain Changes in Traumatic Brain Injury

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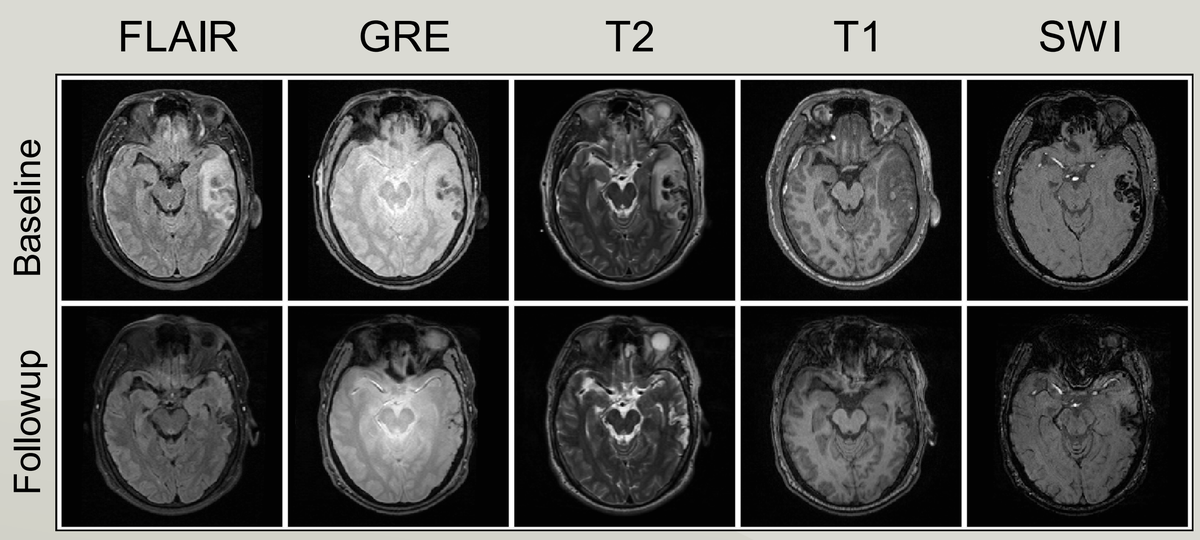
Motivation of TBI Imaging Research

Traumatic brain injury (TBI) occurs when an external force traumatically injures the brain, typically due to car accidents, accidental falls, and wartime injuries. It is a major cause of death and disability worldwide, especially in children and young adults, and it affects 1.7 million Americans annually.

Robust, reproducible segmentations of MR images with TBI are crucial for quantitative analysis of recovery and treatment efficacy. This is a significant challenge due to severe changes such as edema, bleeding, tissue deformation, skull fracture, and other effects related to head injury.

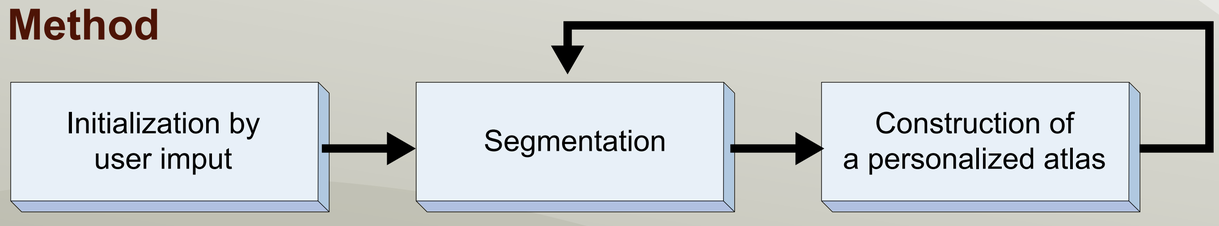
TBI Images



Baseline Lesions
- Swelling (edema)
- Bleeding
- Extracerebral lesion
- Diffuse axonal injury

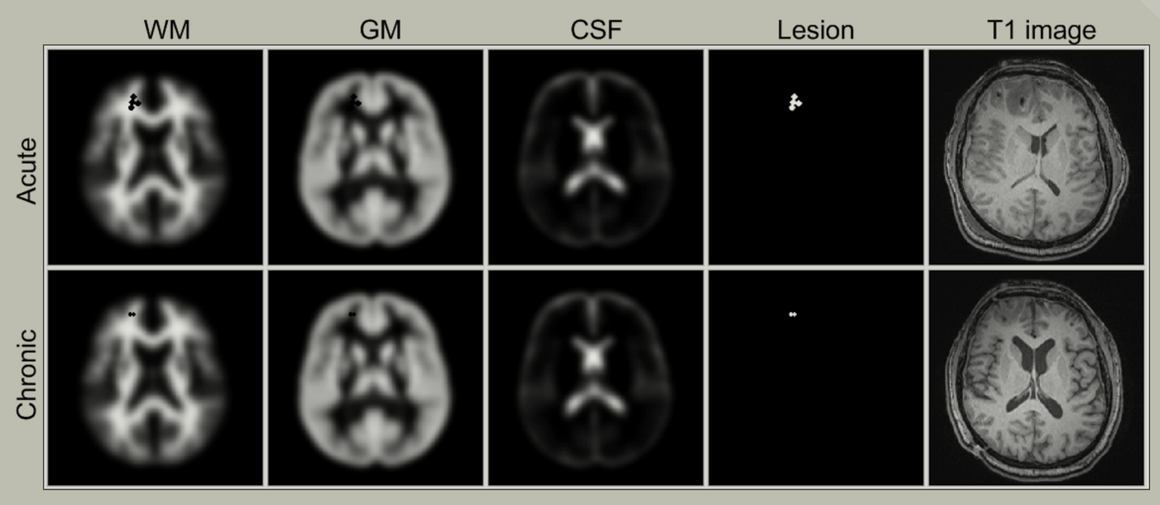
Followup Lesions
- Lesion
- Necrosis
- Bleed

Method



Segmentation framework

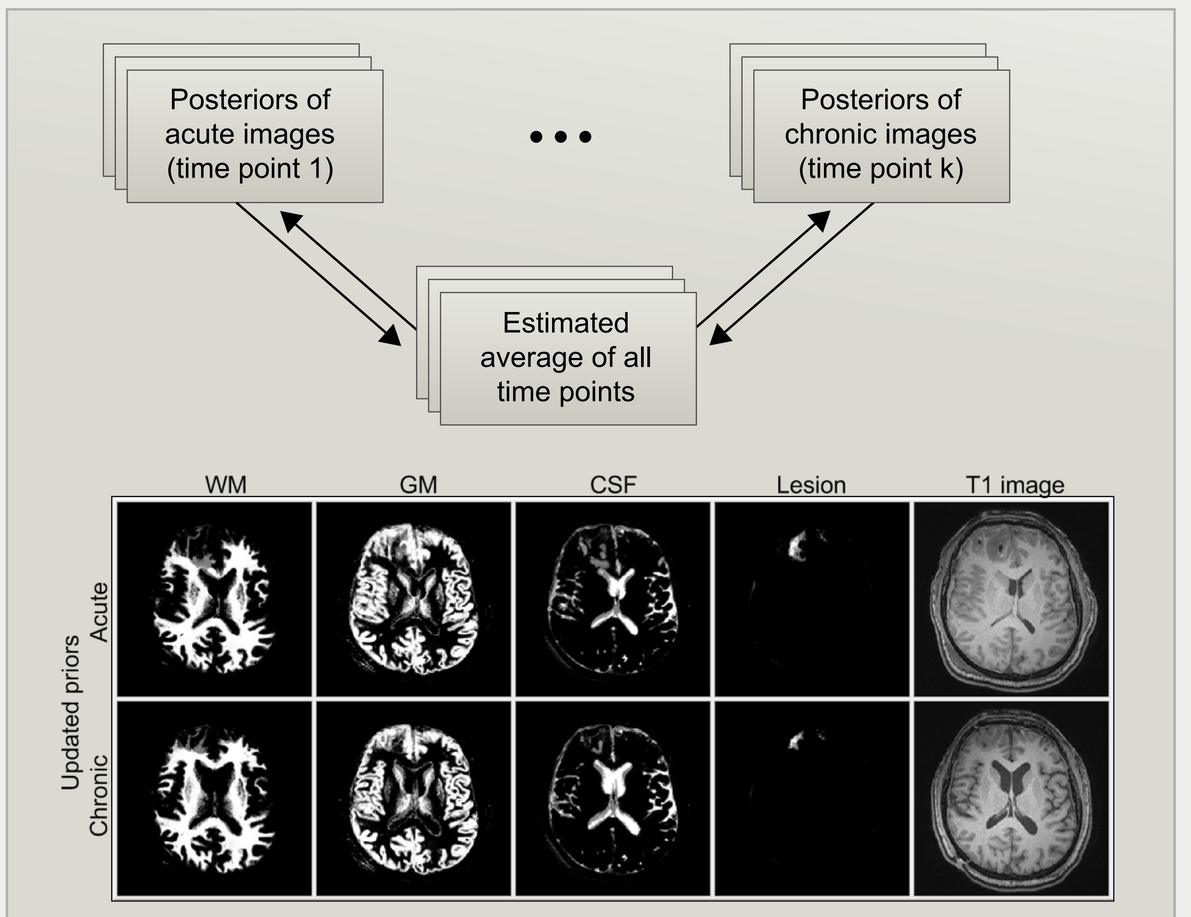
The segmentation framework is initialized through manual input of primary lesion sites at each time point, which are then refined by a joint approach composed of Bayesian segmentation and construction of a personalized atlas. We use mixtures of Gaussians to model the multi-modal MR images.



Axial view of the initial atlas for Subject II

Based on the segmentation results (the posteriors), we create personalized atlases using an unbiased statistical averaging method on shapes with diffeomorphic (smooth, invertible) spatial mapping.

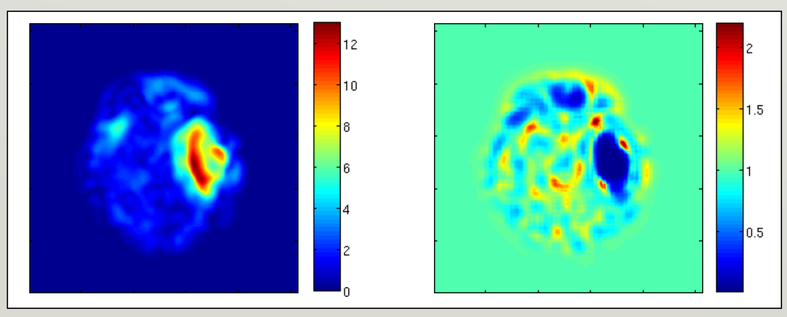
In atlas construction, we estimate an average that requires the minimum amount of deformation to transform into the posteriors at every time point.



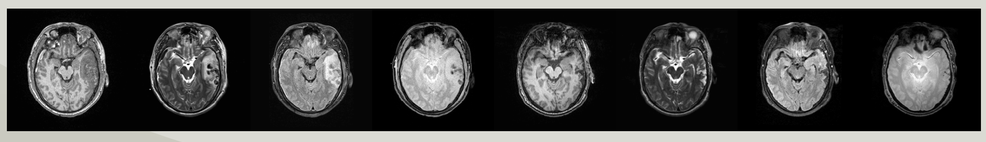
Result of personalized atlas

Conclusions

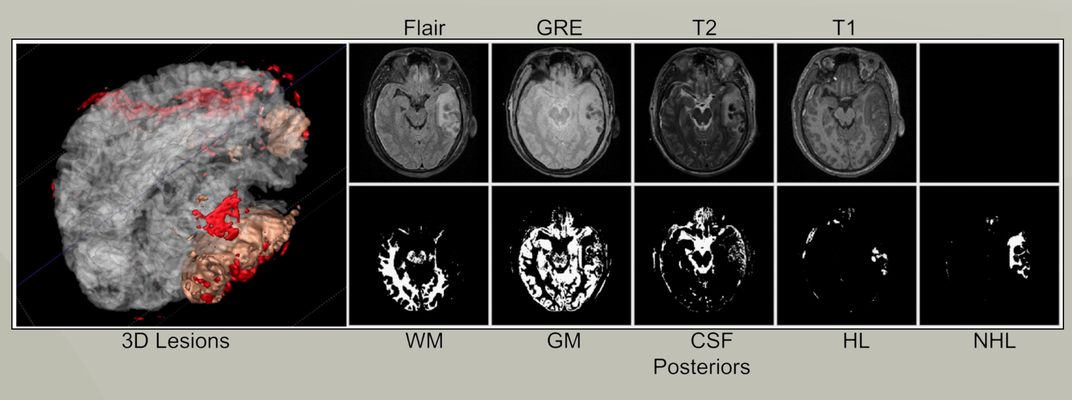
Our method provides reproducible segmentations with little user time. The method generates quantifiable measures for changes over time that allows clinicians to evaluate recovery and treatment efficacy. Moreover, it has the advantage of being able to deal with different sets of modalities at each time point.



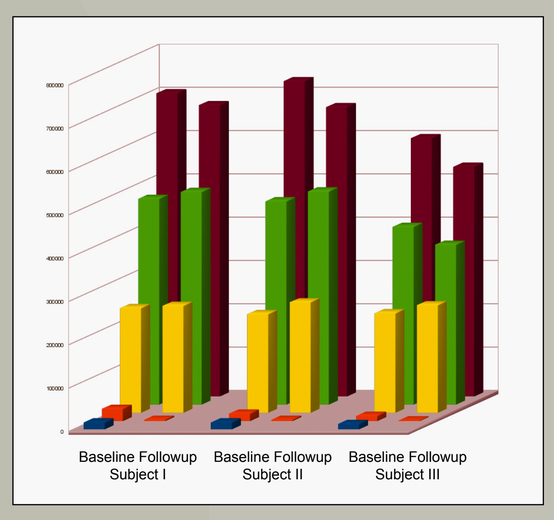
Vector magnitude Jacobian



Visualization of vector magnitude and Jacobian



Results of our method for the acute images of Subject I.



Tissue and lesions volume changes of Subject I, II, and III

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