Quantitative analysis of time series of MR images of TBI patients

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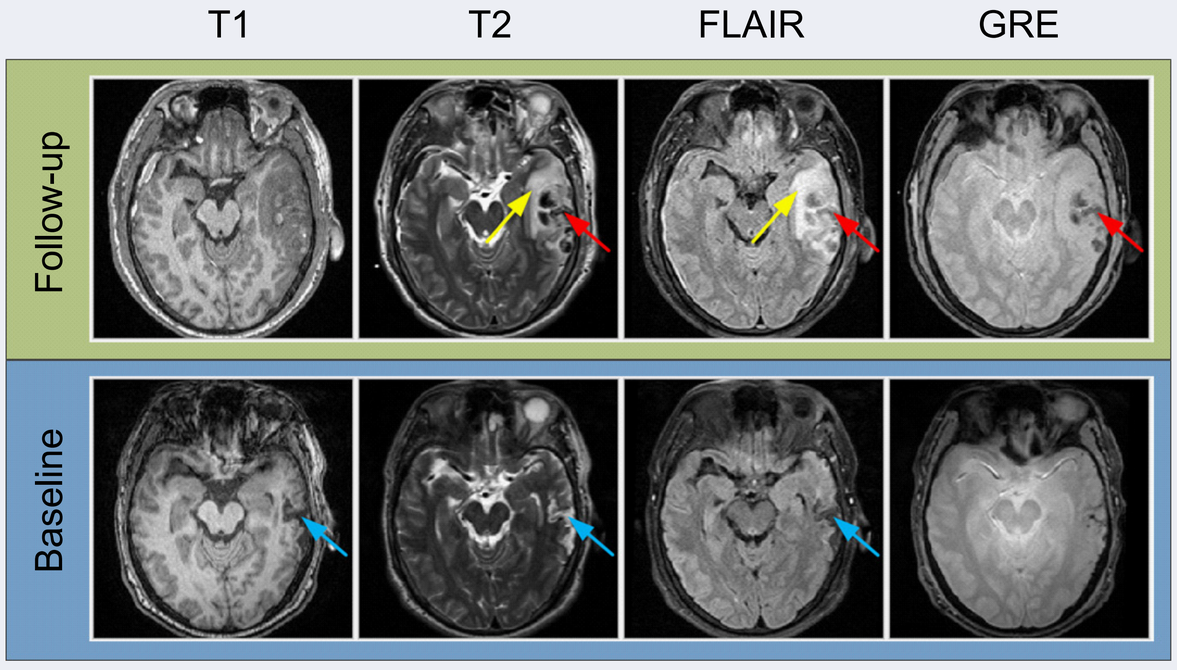
Motivation and challenges of TBI imaging

- Traumatic brain injury (TBI) is a major cause of death and disability and affects 1.5 million Americans annually.
- Images present severe brain changes such as edema, bleeding, tissue deformation, and skull fractures.
- Clinicians do not yet have tools for quantitative analysis to evaluate best treatment options and predict outcome.
- Novel analysis of images taken over time (4D) provides quantitative parameters related to treatment efficacy.

Multicontrast longitudinal images of TBI patients

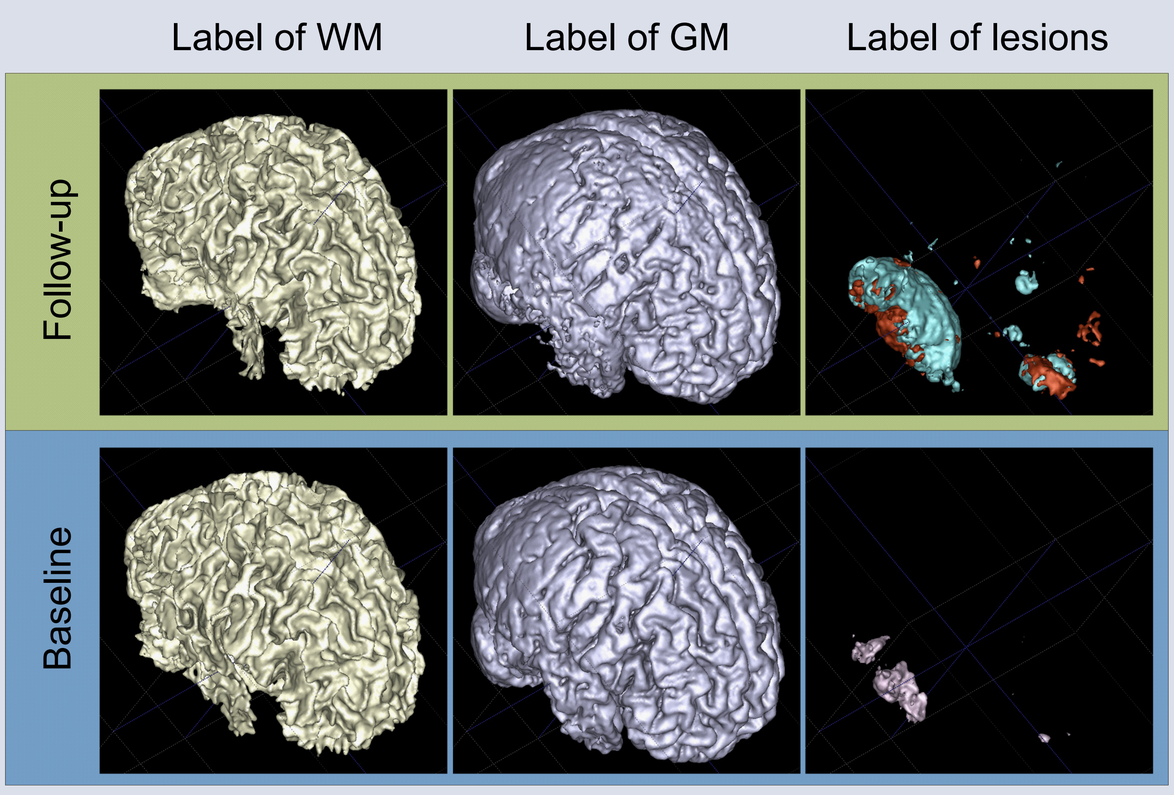


Baseline Lesions
- Swelling (edema)
- Bleeding
- Extracerebral lesion
- Diffuse axonal injury

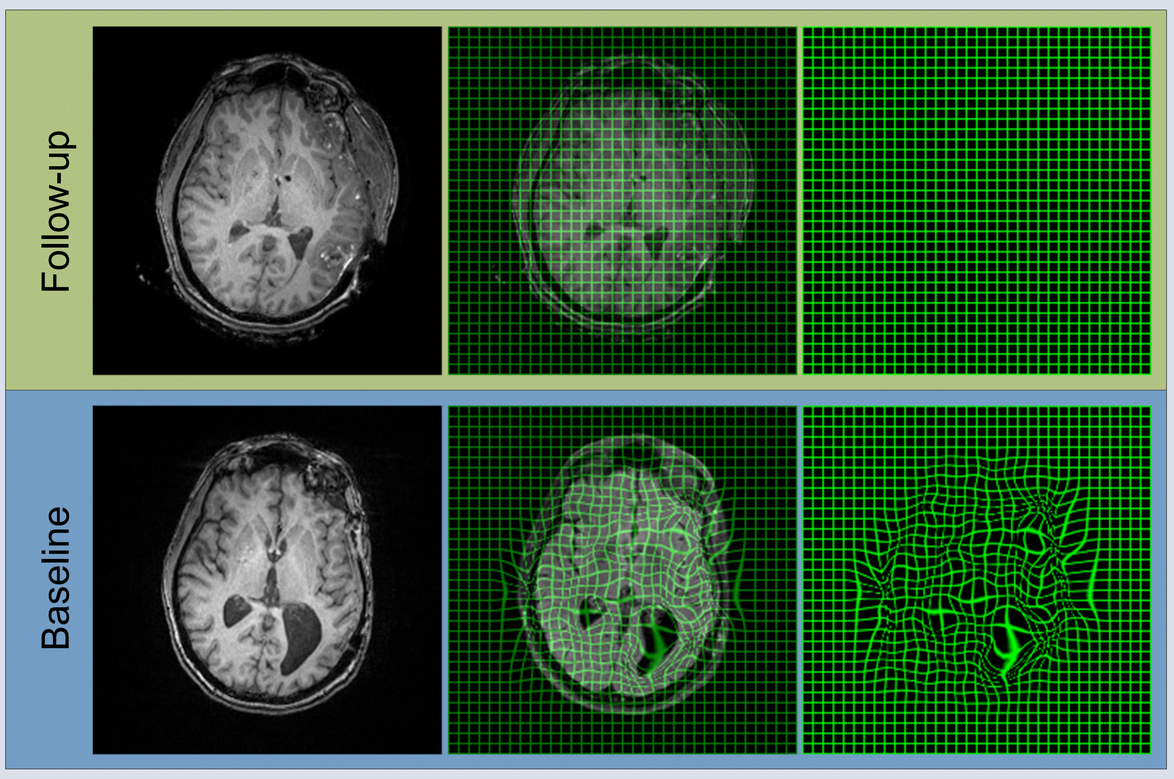
Follow-up Lesions
- Chronic lesion
- Bleeding

Quantitative analysis of longitudinal images (4D)

We develop a joint registration/segmentation method for image time series which provides tissue labels and deformations.



Result of tissue segmentation: Labels of healthy and pathological classes for volume and shape characterization.



Spatiotemporal changes: Deformation field with grid overlay.

Quantitative parameters and visualization

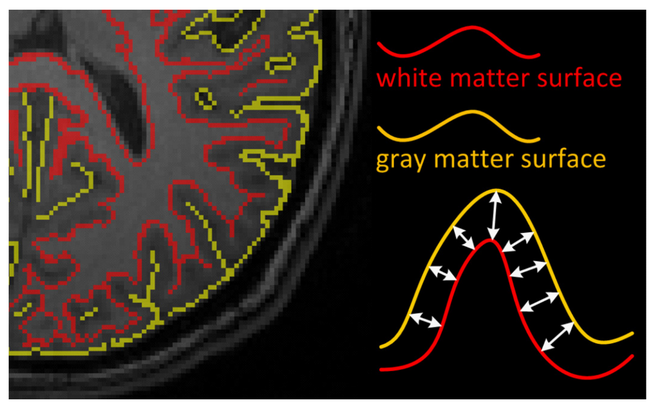
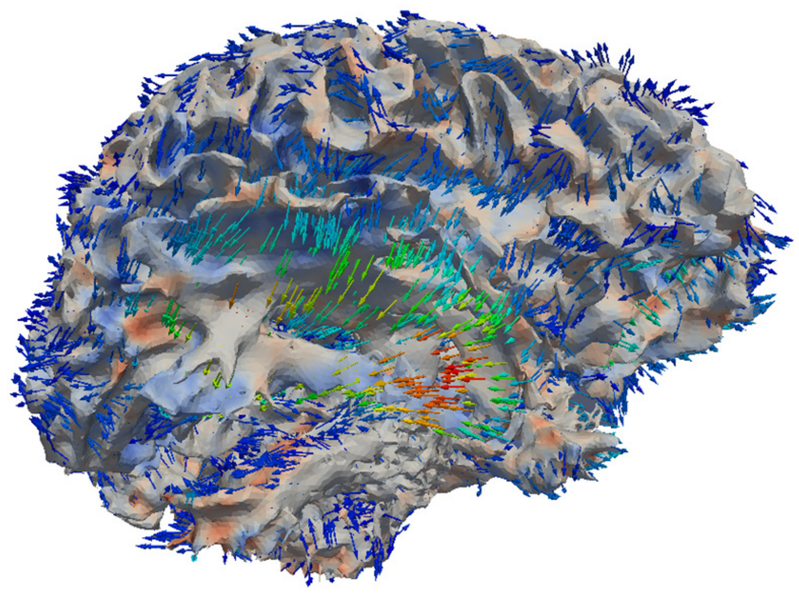
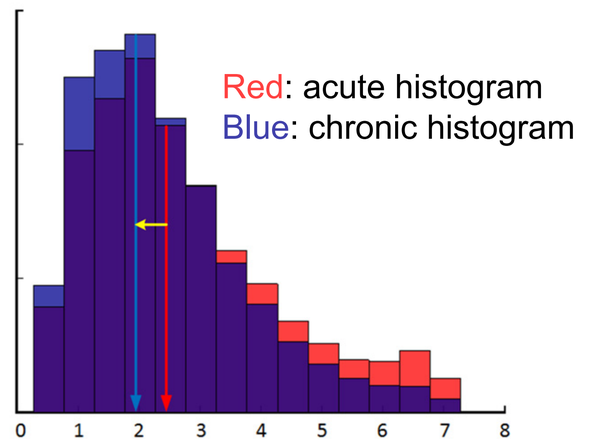


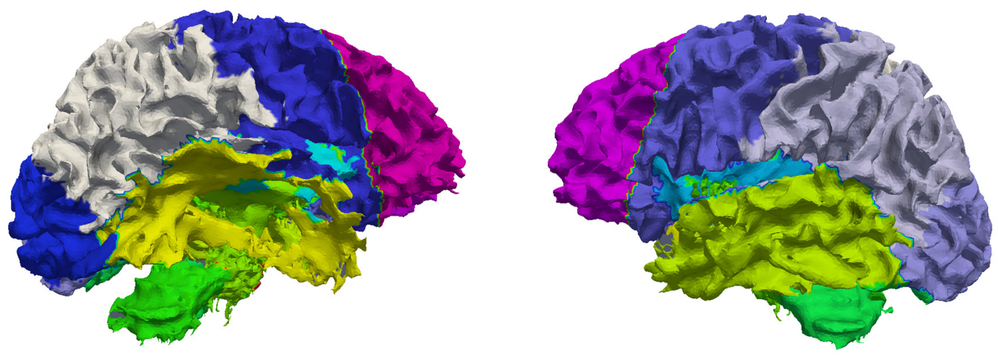
Illustration of cortical thickness.



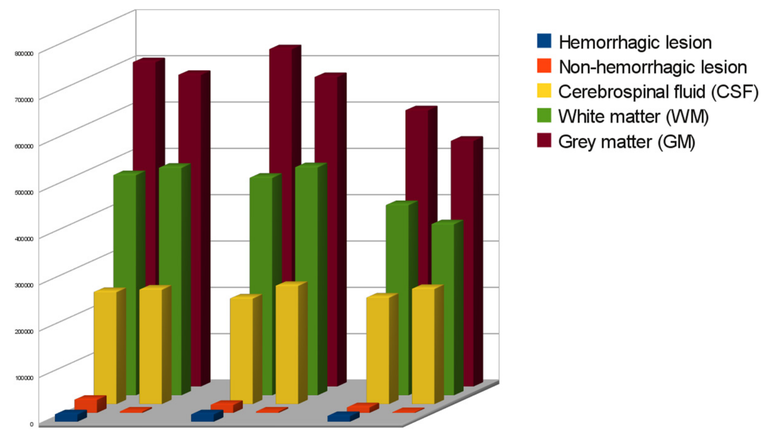
Temporal change of cortical thickness (color) shown with tissue deformation (arrows).



Cortical thickness distribution of whole brain (unit: mm) from acute to chronic.



Anatomical subdivision of brain WM to assess local volume changes.



Tissue and lesion volume changes from acute to chronic.

Conclusion

- Our novel methodology combines 4D image information through the creation of a personalized atlas that explicitly handles complex changes of pathology.
- Processing of longitudinal image data provides patient-specific profiles of tissue and lesion changes.
- First time that clinicians get tools for quantitative assessment of brain changes related to therapeutic intervention and recovery → Leads to improved decision making on optimal intervention strategy.