

## Association Between Resistance to Cerebrospinal Fluid Flow and Cardiac-Induced Brain Tissue Motion for CMI

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### Purpose

CMI subjects have been shown to have greater neural tissue motion during the cardiac cycle compared to healthy controls. In addition, resistance to cerebrospinal fluid (CSF) flow in the spinal canal has also been shown to be greater for CMI subjects compared to healthy controls. The goal of this study is to determine if a relationship is present between brain tissue motion and CSF resistance.

### Methods

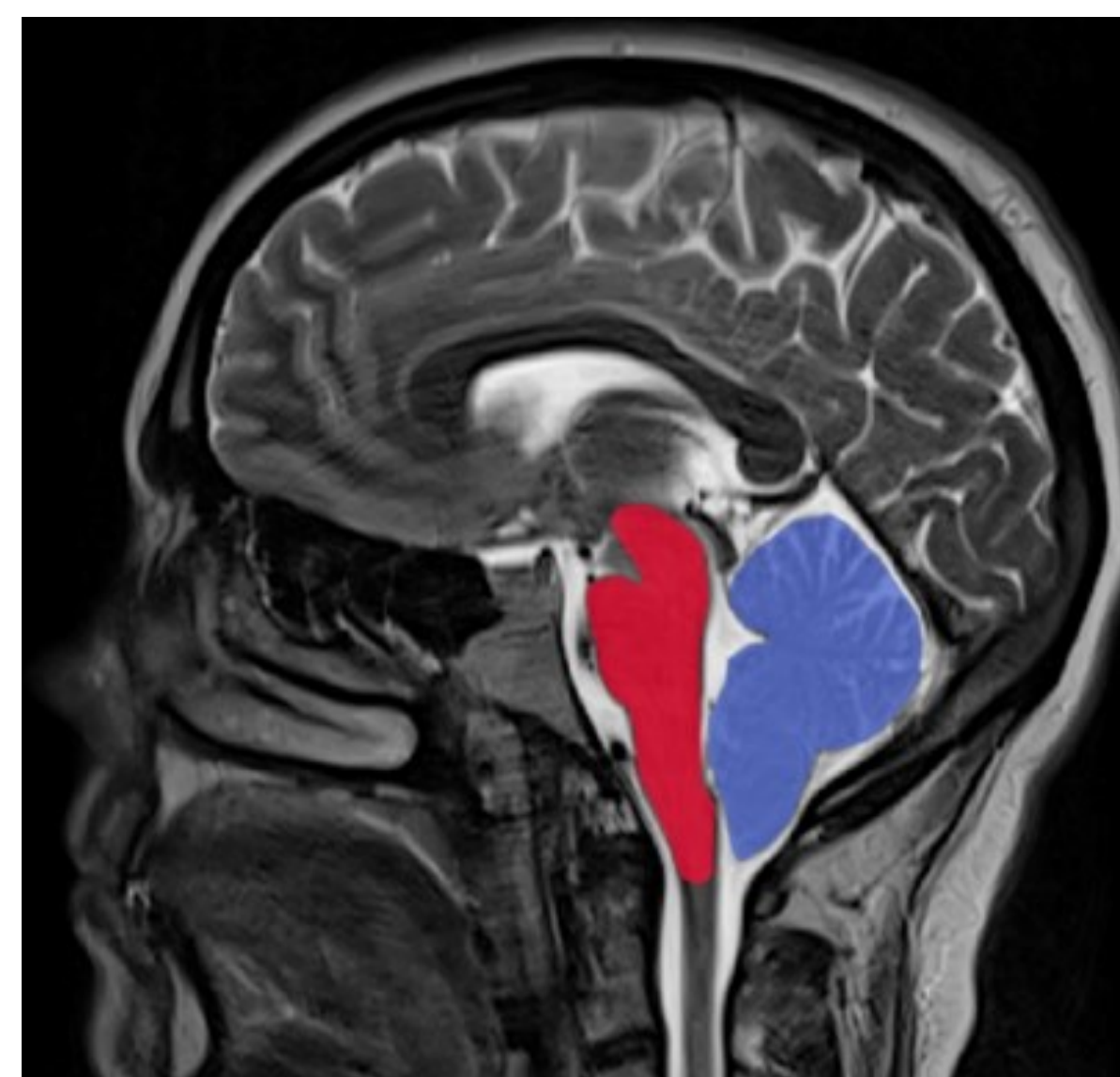
Thirty-two CMI patients and eighteen healthy controls subjects were analyzed by determining each subject's specific *Integrated Longitudinal Impedance* (ILI, resistance to CSF flow) from MRI and also their brainstem and cerebellum movement (displacement) during the cardiac cycle. ILI was calculated using computational fluid dynamics techniques and neural tissue during the cardiac cycle was quantified using DENSE MRI. The correlation between ILI and displacement of the cerebellum and brainstem was then calculated.

### Results

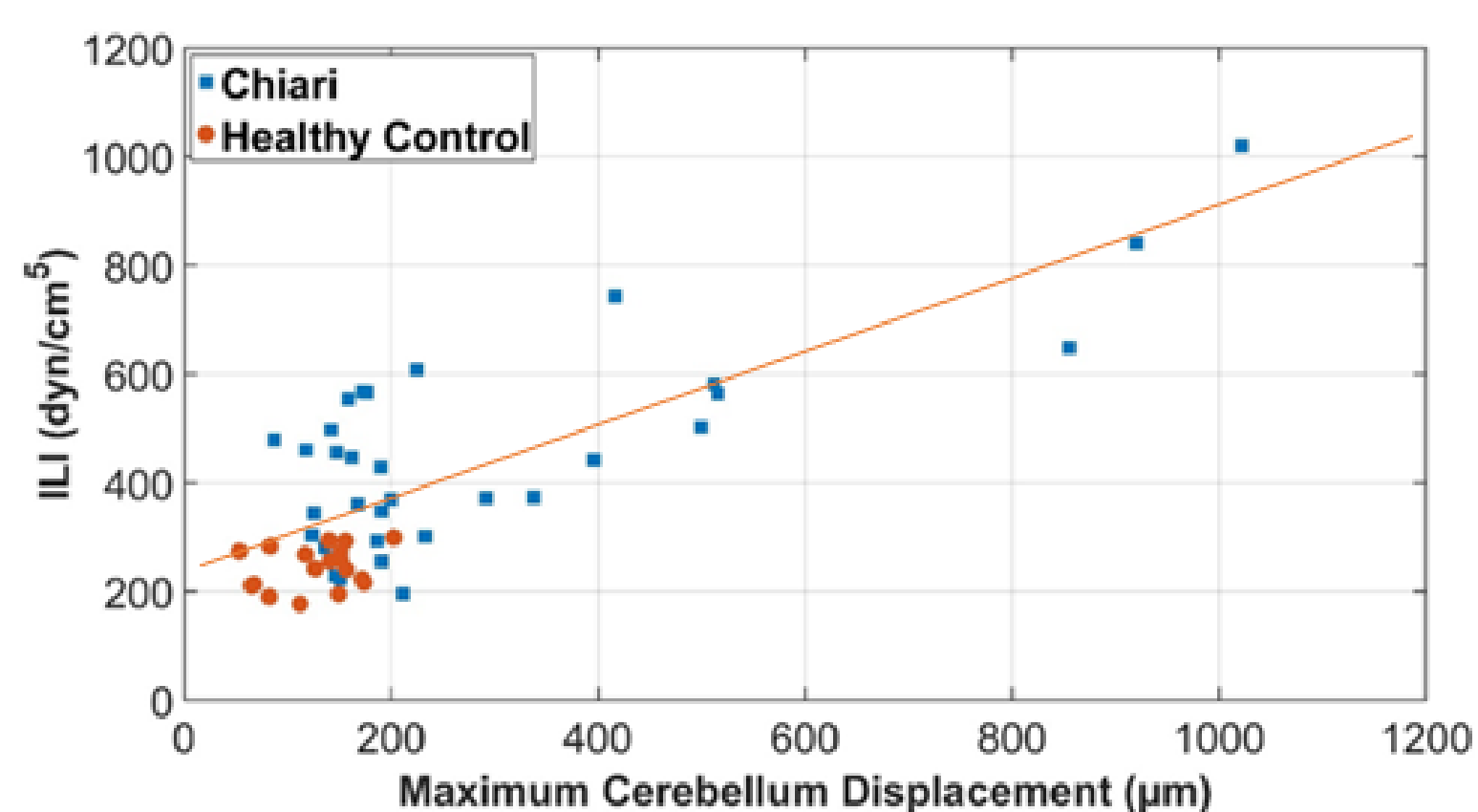
Both resistance to CSF flow and brain tissue motion during cardiac cycle are larger in CMI patients than healthy subjects. The results demonstrated a positive correlation between ILI and the maximum tissue displacement for all subjects (CMI and healthy) in both cerebellum ( $r=0.78$ ,  $p<10^{-10}$ ) and brainstem ( $r=0.44$ ,  $p=0.001$ ).

### Conclusions

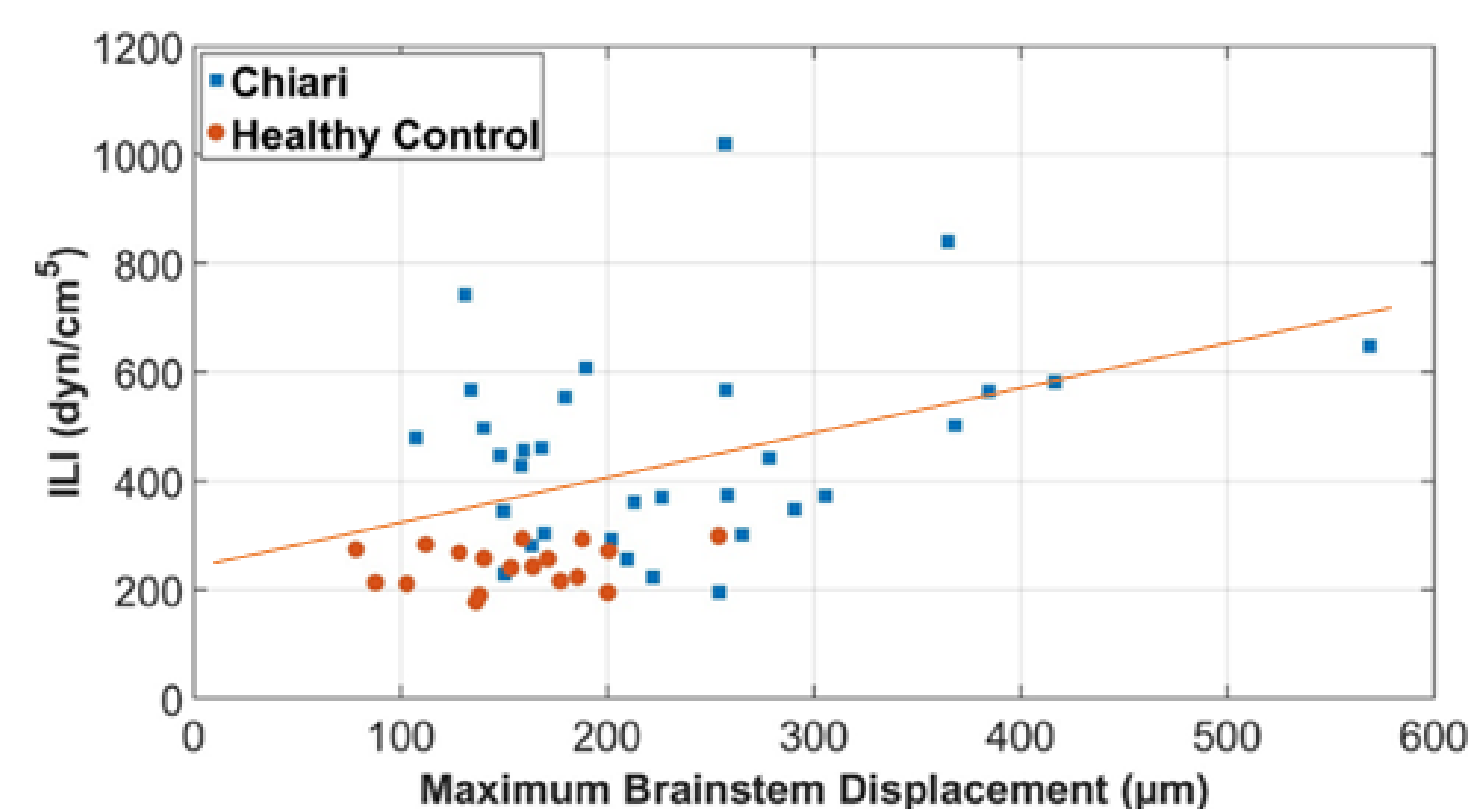
This study combined computational fluid dynamics and an advanced MRI protocol to show that a relationship exists between resistance to CSF flow in the spinal canal and motion of the cerebellum and brainstem during the cardiac cycle. More work on this subject is required, but it could be that the extra motion of the cerebellum and brainstem seen in Chiari patients is caused by CSF resistance.



Cerebellum (Blue) and Brainstem (Red) on a DENSE MRI



ILI versus maximum tissue displacement at the cerebellum for Chiari subjects and healthy controls



ILI versus maximum tissue displacement at the brainstem for Chiari subjects and healthy controls