Conquer Chiari Research Center

Conquer Chiari — From Knowledge, Strength. Through Research, Hope.

Functional connectivity abnormalities in Type I Chiari: Associations with cognition and pain

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Purpose

There is initial evidence of microstructural abnormalities in the fiber-tract communication pathways of the cerebellum and cerebrum of individuals diagnosed with Type I Chiari malformation (CMI). However, it is unclear whether abnormal white matter architecture and macro-level morphological deviations that have been observed in Chiari translate to differences in functional connectivity between areas of the brain. Furthermore, common symptoms of CMI include pain and cognitive deficits, but the relationship between these symptoms and functional connectivity has not been explored.

Methods

Eighteen CMI patients and 18 age-, sex- and education-matched controls underwent resting-state functional MRI to measure functional connectivity. Participants also completed a neuropsychological battery and completed self-report measures of chronic pain. Group differences in functional connectivity were identified. Subsequently, pathways of significant difference were re-analyzed after controlling for the effects of attention performance and self-reported chronic pain.

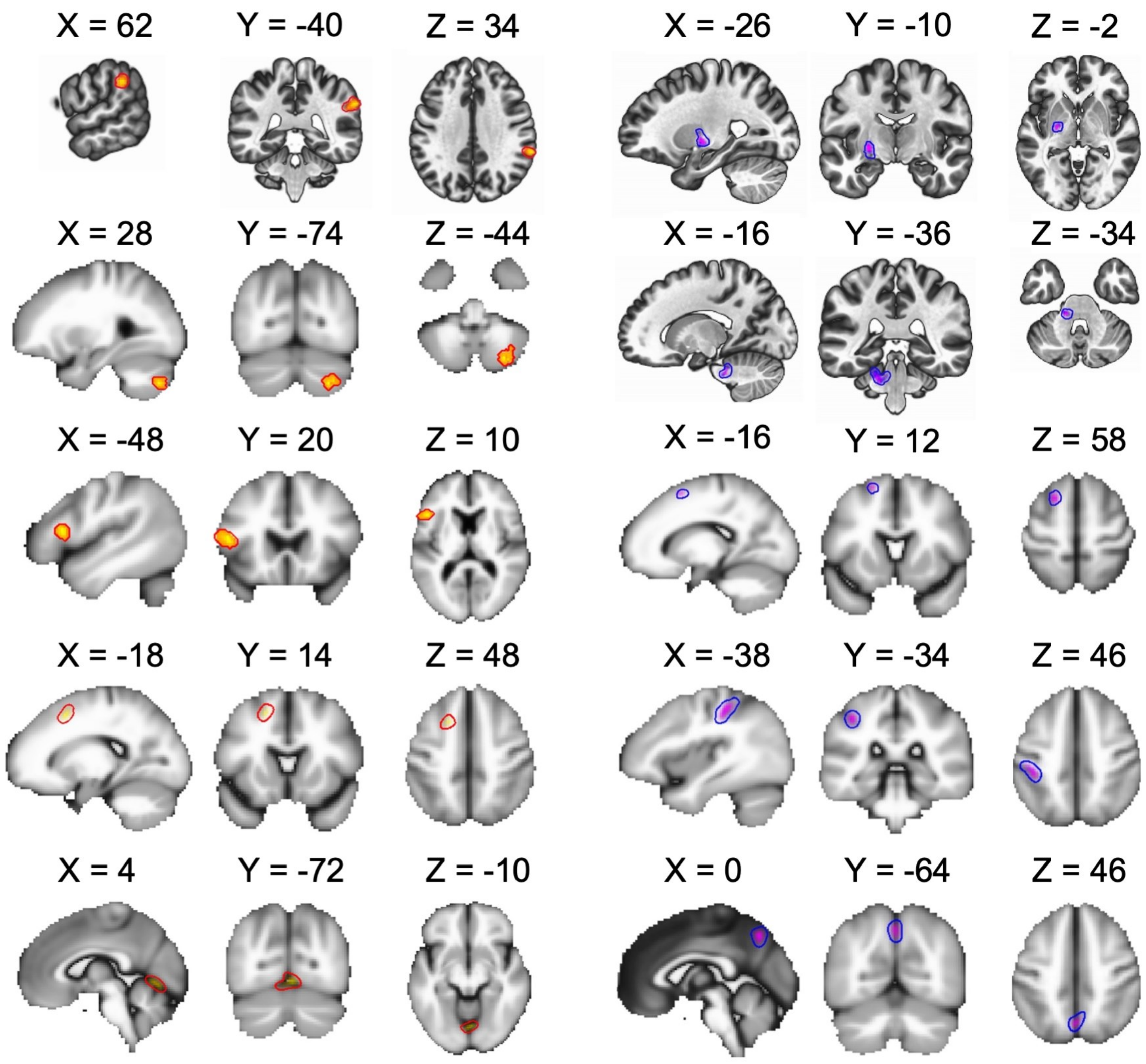
Results

CMI patients exhibited functional hypoconnectivity between areas of the cerebellum and cerebrum along with attentional deficits and greater reported pain. Controlling for attention and pain could account for much of the observed CMI hypoconnectivity. Patterns of CMI hyperconnectivity were also found between regions of the cerebellum and cerebrum in CMI patients. These differences were again largely associated with attentional deficits and pain.

Conclusions

Evidence of brain hyper- and hypoconnectivity were identified in CMI that is posited to support the hypothesis that the effect of increased pain in CMI draws neural resources, requiring an upregulation in attentional control and resulting in cognitive dysfunction. Areas of hypoconnectivity in CMI patients also suggest disruption in functional brain pathways due to prolonged pain experiences.

Regions of significant group differences in functional connectivity between CMI patients and controls



Resting-state fMRI analysis yielded patterns of Chiari-related hypoconnectivity (Controls > CMI—yellow) & hyperconnectivity (CMI > Conrols—magenta) between seeds and areas of connectivity.

Seed	Contrast	Region of Interest	MNI Coordinates (X, Y, Z)	Beta	Peak *T* -value	*p*-FDR	Cluster Size (Voxels)*
Posterior Cingulate Cortex	*CMI>Controls*	Left Globus Pallidus	(-26, -10, -02)	-0.19	-5.95	< .001	198
		Left Parahippocampal Gyrus	(-16, -36, -34)	-0.19	-5.51	< .001	166
	Controls>CMI	-	-	-	-	-	-
Posterior Cerebellar Pathway	*CMI>Controls*	-	-	-	-	-	-
	Controls>CMI	Right Supramarginal Gyrus	(62, -40, 34)	0.29	4.66	< .001	248
Crus I	*CMI>Controls*	Left Superior Frontal Gyrus	(-16, 12, 58)	-0.21	-5.33	< .001	169
	Controls>CMI	-	-	-	-	-	-
Left Lobule III	*CMI>Controls*	-	-	-	-	-	-
	Controls>CMI	Left Inferior Frontal Gyrus	(-48, 20, 10)	0.18	5.29	< .001	144
		Right Crus 2	(28, -74, -44)	0.19	5.20	< .001	149
Left Lobule VIII	*CMI>Controls*	Left Postcentral Gyrus	(-38, -34, 46)	-0.18	-6.20	< .001	617
	Controls>CMI	-	-	-	-	-	-
Vermis I and II	*CMI>Controls*	-	-	-	-	-	-
	Controls>CMI	Left Superior Frontal Gyrus	(-18, 14, 48)	0.18	5.08	< .001	145
Vermis VII	*CMI>Controls*	-	-	-	-	-	-
	Controls>CMI	Right Lingual Gyrus	(4, -72, -10)	0.28	5.32	<.001	250
Vermis IX	*CMI>Controls*	Precuneus	(0, -64, 46)	-0.25	-4.74	< .001	272
	Controls>CMI	-	-	-	-	-	-
Frontoparietal Attentional Pathway	*CMI>Controls*	-	-	-	-	-	-
	Controls>CMI	-	-	-	-	-	-