Cranial Expansion In Nonsyndromic Sagittal Synostosis Re-Establishes Resting Connectivity Patterns By Functional MRI

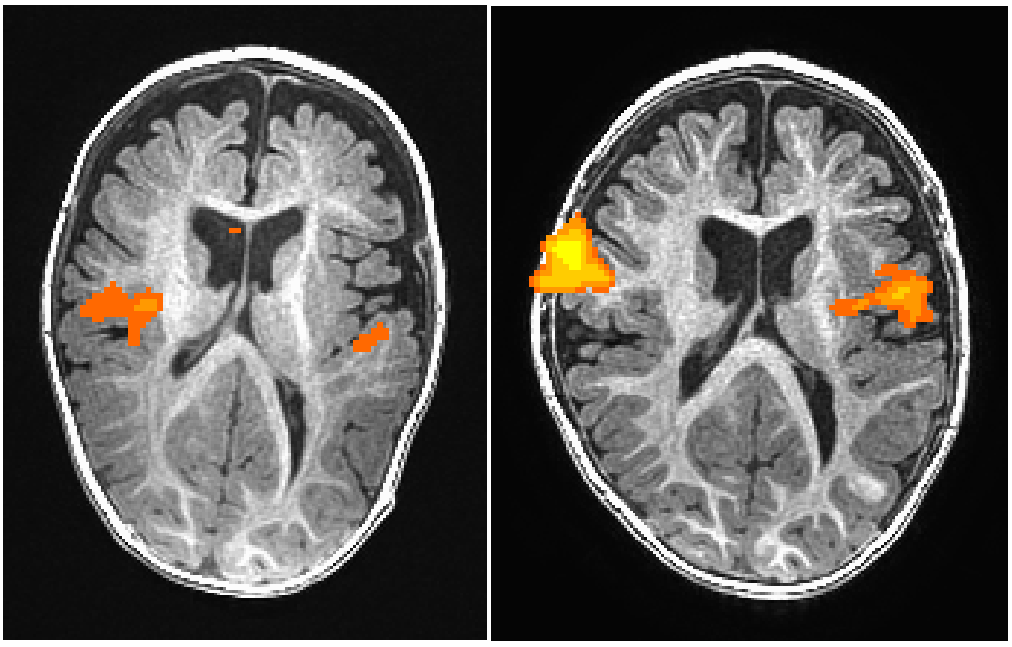
John N Jensen, MD, Rupeng Li, MD, PhD, Sean M Lew, MD, Andrew B Foy, MD, Christopher Pawela, PhD, Bruce A Kaufman, MD, Medical College of Wisconsin and Children's Hospital of Wisconsin, Milwaukee, WI

PURPOSE: To introduce resting-state connectivity fMRI as a tool to investigate early neurofunctional impact of surgical intervention (cranial expansion) in infants with non-syndromic sagittal synostosis.

METHODS: Six healthy infants with non-syndromic sagittal synostosis underwent preop fMRI scan without sedation (mean age 26 wks), followed by open cranial vault expansion (mean 30.5 wks), followed by post-op fMRI scan (mean 43 wks) with IRB approval. Resting connectivity was selected as it is a task-independent metric and can provide useful information with regard to generalized brain function in newborns. Sleeping subjects were placed supine in a 3.0T General Electric Signa LX scanner equipped with a 32 channel receiver head coil. A fast axial 3 dimensional Spoiled Gradient Echo (3D-SPGR) image was acquired for each single subject before functional imaging session, consisting of 150 slices acquired: slice thickness of 1mm, TR=8.2ms, TE=3.2ms, flip angle=12 degree, FOV=240mm, matrix=256X224. High resolution anatomical images were used for subsequent superimposition of the low–resolution functional MRI data. Functional EPI scans were acquired at a slice thickness of 2.5mm, total 31 slices, FOV 240mm, TR=2000 ms, TR=22 ms, flip angle=77 degree, matrix=96X96. Analysis of Functional Neuroimaging (AFNI) software was used to register and analyze imaging data, and identify neural networks demonstrating altered resting connectivity before and after surgery.

RESULTS: Early data acquisition was plagued by motion artifact and physiologic perturbation confounding the results. The focus of this report compares clean pre- and post-operative datasets in the same individual; preliminary analysis confirms improved resting state connectivity in both the visual and sensorimotor networks, both in amplitude of BOLD signal and the extent of the networks. Furthermore, the networks in general in several subjects show improved symmetry following surgery.

CONCLUSIONS: Resting-state connectivity fMRI is a sensitive and objective means of measuring functional impact on brain function of surgical treatment, and can be safely employed in infants. In cranial surgery the acute expansion of the intracranial space undoubtedly affects intracranial pressure dynamics, which impacts neuronal activity reflected in an altered BOLD signal. If preservation of brain function is the overarching goal of surgery, and not simply cosmesis, fMRI will provide the means to prove it, as well as have future application as an objective measure by which to validate more traditional neuropsychological testing in this population.



Pre-op Post-op