# Interhemispheric Connectivity in ICH

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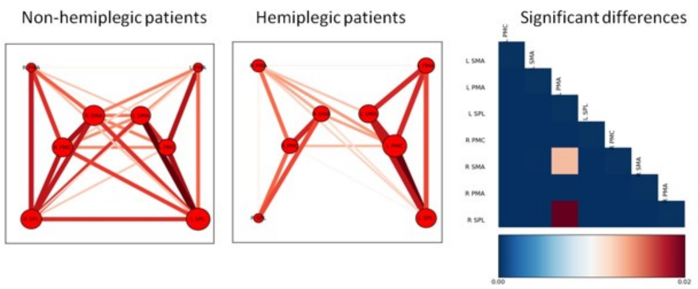
## Introduction

Intracerebral hemorrhage (ICH) has the highest mortality of all stroke subtypes. Motor deficits are a major cause of ongoing disability after ICH. However, the underlying pathophysiology of motor deficits after ICH is not clear. The significance of connectivity between primary motor cortex (PMC) and other areas, especially contralateral PMC, has been debated. One school of thought suggests that contralateral M1 activation is always dysfunctional and that therapeutic strategies should be directed towards inhibiting it and restoring balance (1,2). Another interpretation suggests that contralateral M1 activation is required for early recovery and becomes inhibitory/pathological at later timepoints (3,4). We hypothesized that: 1.) Connectivity within the motor network will be decreased in hemiplegic patients relative to non-hemiplegic patients, and 2.) group analysis will show evidence of contralateral connectivity in non-hemiplegic but not in hemiplegic patients.

## Methods

We enrolled six left-sided ICH patients with hemorrhages within the basal ganglia and/or thalamus, and we performed both structural and resting-state functional MRI. Patients were divided into a hemiplegic group and a non-hemiplegic group. Seed-based analyses were performed to evaluate motor networks. Graphs were constructed between key nodes in the motor network. Mean edge weights, as well as directional connectivity using Granger causality were derived.

### Total motor network connectivity after L-sided ICH

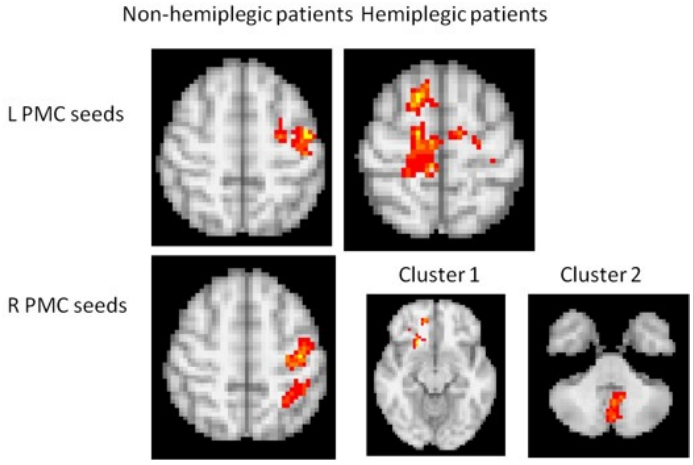



Motor networks were derived from cross-correlation analyses of the timeseries derived from the PMC, PMA, SMA, and SPL bilaterally. The motor network is significantly more connected in non-hemiplegic patients (panel A) than hemiplegic patients (panel B). Taking the mean connectivity of each edge and comparing hemiplegic to non-hemiplegic patients, significant differences were seen in R SMA – L PMA and R SPL – L PMA connectivity ($p<0.05$ for both, uncorrected).

## Conclusions

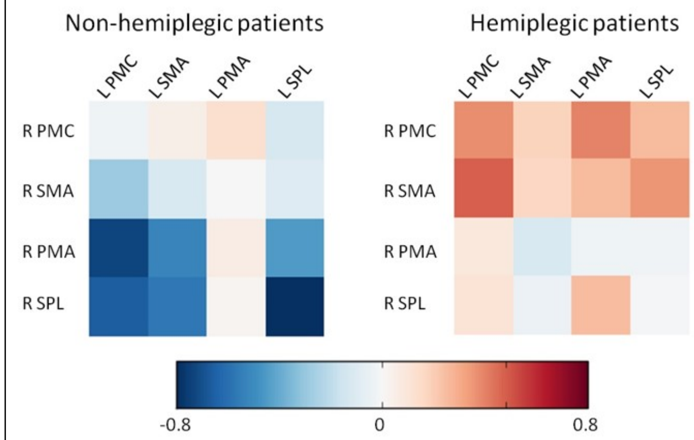
Resting fMRI differentiates hemiplegic and non-hemiplegic patients after thalamic/basal ganglia ICH. These data, while preliminary, support a role for interhemispheric connectivity in recovery from stroke. Specifically, information flow from left to right is associated with maintenance of strength after hemorrhage and flow right to left is associated with potentially an inhibitory influence.

### Primary motor cortex connectivity in hemiplegic and non-hemiplegic subjects




Top row: L PMC-derived maps in the non-hemiplegic patients showed significant cross-correlation in the local area only; in hemiplegic patients, cross-correlation extended to the contralateral hemisphere. Bottom row: R PMC-derived maps in the non-hemiplegic patients showed cross-correlation in the contralateral, left primary motor cortex, as well as in parietal areas. Hemiplegic patients had no contralateral cross-correlation, but rather had correlation seen in the ipsilateral frontal lobe and in the cerebellum. Threshholded at Z=2.3, $p<0.05$ (corrected)

### Granger causality following ICH




Causality analysis was applied to timeseries data, and adjacency matrices indicating causality were constructed. Negative numbers (blue on the color bar) imply left-to-right causation, whereas positive numbers (red on the color bar) imply right-to-left causation.

## References

1. Calautti C, Naccarato M, Jones PS, et al. The relationship between motor deficit and hemisphere activation balance after stroke: A 3T fMRI study. Neuroimage. 2007 Jan 1;34(1):322-31.
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