Spontaneous posteromedial voxel-based connection density in comatose patients

Brigitta Malagurski1, Patrice Péran1, Stein Silva1
1. Toulouse NeuroImaging Center, Université de Toulouse, Inserm, UPS, France

**Background**

* Major consciousness deficit observed in coma is related to the breakdown of long-range neuronal circuits supported by the posterior medial cortex (PMC) [1,2].
* The strength of functional connectivity between the PMC and the medial prefrontal cortex (mPFC) seems related to the neurologic outcome of comatose patients [2].

**Objectives**

We studied:
* voxel-based positive and negative connection density between anatomical (precuneus and posterior cingulate cortex) and functional (ventral/dorsal) subregions of the PMC and the mPFC;
* specific impact of brain injury mechanisms (anoxic and traumatic) on PMC-to-mPFC functional connectivity;
* the prognostic value for neurologic recovery of PMC connection density data.

**Data analysis pipeline**

- SPM8 Realignment
- Slice-timing correction
- Normalization
- CONN 13f
- Noise reduction
- Motion parameters
- sCompCor
- Band-pass filtering
- 0.006-0.05 Hz
- ROI selection
- AAL atlas
- Matlab script
- Pearson’s r correlation map
- Fisher’s r-to-z transformation
- Subject-specific threshold P < 0.05

**Methods**

Participants: 27 comatose patients (15 traumatic and 12 anoxic) and 14 age-matched control subjects.

Regions of interest (ROI): AAL atlas (voxel size 2mm) - PMC (12186 voxels - precuneus (PreCu) and posterior cingulate cortex (PCC)) and mPFC (13389 voxels - frontal superior medial L/R and anterior cingulate cortex L/R).

Connection density: Number of significant connections between a single PMC voxel and all of the mPFC voxels. Z-score was calculated to obtain individual patient results.

Prognostic: Spearman’s correlation with PMC connection density data and the Coma Recovery Scale-Revised score (CRS-R) (Fig.3).

**Results**

**Fig.1.** PMC connection density group results for comatose patients:
* Ventral PCC and ventral PreCu seem to form a functional cluster of hypo positive connection density (CD) voxels;
* Hyper positive CD voxels appear to be restricted to the dorsal sub-regions of both PreCu and PCC;
* Hyper negative CD voxels are widespread, covering most of the PMC.

**Fig.2.** Anatomical sub-regions and aetiology differences:
* Anoxic brain injury (BI) patients seem to exhibit more voxels with hypo positive CD, mainly located in the posterior cingulate sub-region (PCC).
* Traumatic BI patients show a higher percentage of hyper negative CD voxels also highly present in the PCC sub-region.

**Fig.3.** Prognostic:
* Patients with high number of PMC voxels with hypo positive CD are less likely to recover (r=-0.72, p=.00002).
* In traumatic brain injury patients, high number of hyper negative CD voxels indicated worse recovery at 3 months post-coma (r=-0.86, p=.00005).

**Conclusions**

* Topography of PMC connection density changes seems to imply an imbalance between internal/external processing systems;
* Greater prevalence of hyper negative connections in traumatic brain injury patients, possibly indicating maladaptive brain plasticity;
* Preserved positive connection density between PMC (ventral PreCu/PCC) seems related to the neurological recovery of comatose patients;
* An increase of negative connection density appears to be linked to poor recovery in traumatic BI patients.