Preoperative PCC Microstructural Damage is linked to Intraoperative EEG Response to Anesthesia and Postoperative Delirium

Cole Kannam*; Tyler Reekes, PhD; Mary C. Wright, MS, Melody Reese, PhD; Miles Berger, MD/PhD; Jeffery Browndyke, PhD; Micheal J Devinney, MD/PhD

INTRODUCTION

Post-operative delirium (POD) is the most common surgical complication in older adults and is linked with poor cognitive and clinical outcomes. While microstructural damage to the posterior cingulate cortex (PCC) has been associated to increased POD risk, the functional consequences of this damage are not well understood.

We hypothesize that greater preoperative PCC damage will be associated with reduced intraoperative EEG alpha power under anesthesia—a marker of impaired brain response and resilience—and that this relationship will, in turn, be associated with the development of delirium.

METHODS

Participants:
- 29 patients aged ≥60 years
- Undergoing non-cardiac, non-intracranial surgery

Neuroimaging:
- Preoperative MRI scans using neurite orientation dispersion and density imaging (NODDI)
- Assessed microstructural integrity of the posterior cingulate cortex (PCC)

EEG Recording:
- Intraoperative frontal-parietal EEG alpha power extracted
- Alpha power adjusted for anesthetic dose

Analysis:
- Tested associations between EEG alpha power and PCC integrity metrics:
  - Free water (FISO)
  - Orientation dispersion index (ODI)
  - Neurite density index (NDI)

RESULTS

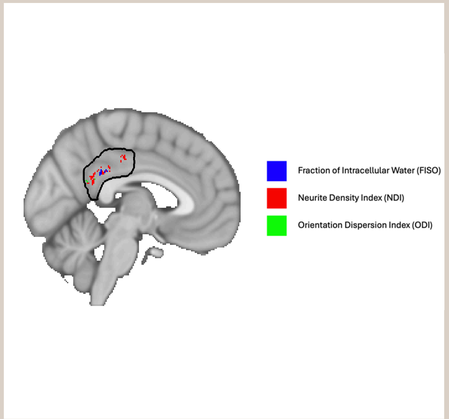


Figure 1: Posterior cingulate cortex region of interest
Sagittal view showing the PCC subregion used for NODDI analysis. Overlays indicate extracted metrics: FISO (blue), NDI (red), and ODI (green).

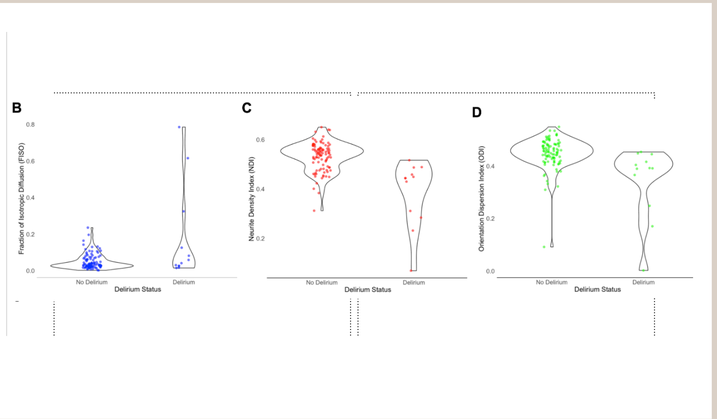


Figure 2: PCC microstructure metrics by delirium status
Violin plots show differences in PCC free water (FISO, B), neurite density (NDI, C), and orientation dispersion (ODI, D) between patients with and without postoperative delirium. Delirious patients showed trends toward higher FISO and lower NDI.



Figure 3: Intraoperative alpha power differs by delirium status
Delirious patients showed significantly lower dose-adjusted FP alpha power during anesthesia ($p = 0.032$). Error bars represent SEM.

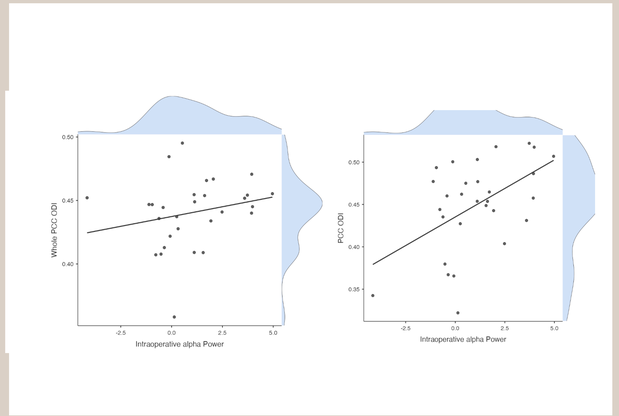


Figure 4: PCC dendritic complexity is associated with alpha power
Higher dose-adjusted alpha power correlated with greater PCC ODI, especially in a targeted subregion (left). Whole-PCC association was weaker (right).

CONCLUSIONS

1. PCC dendritic complexity (ODI) also negatively correlated with alpha power.
2. These results suggest a potential structure-function link between PCC damage and reduced brain response under anesthesia.
3. This relationship may reflect increased vulnerability to POD in older adults.

FUTURE DIRECTIONS

- We are currently enrolling a larger cohort of 200+ older surgical patients in the ALADDIN study, all undergoing preoperative MRI and intraoperative EEG, to validate and expand upon these findings.
- Examine how predisposing and precipitating factors relate to postoperative delirium and postoperative cognitive decline.
- Expand NODDI analysis to the whole brain to identify additional vulnerable regions or networks.

Integrate imaging and EEG markers to develop clinical tools for preoperative risk stratification.

ACKNOWLEDGEMENTS

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