A new biomarker to guide neuromodulatory treatment for patients suffering from post-concussion syndrome and chronic pain

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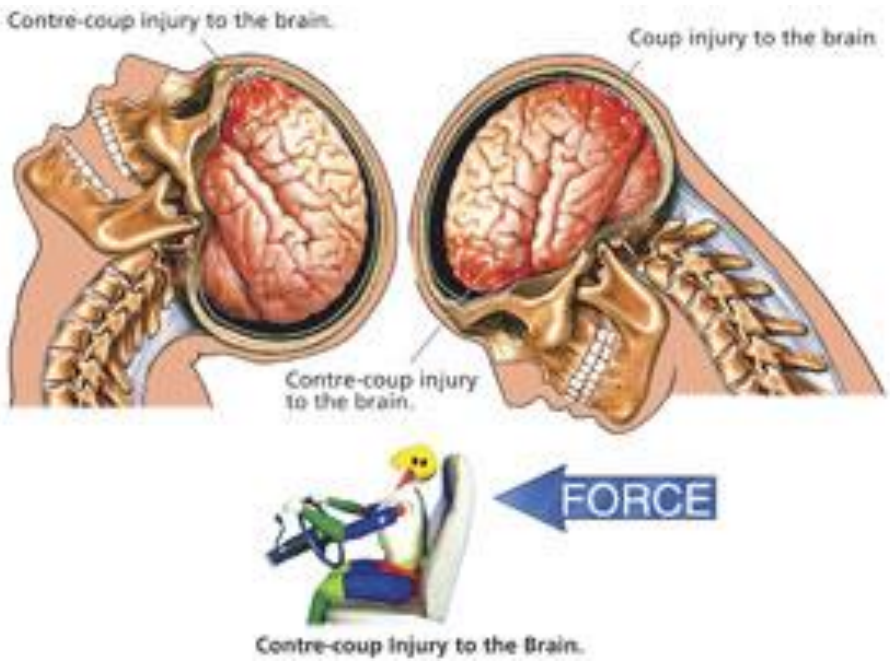
Mild Traumatic Brain injuries from Motor Vehicle Accidents

- **Goal:** Identify specific pathological brain states “biomarkers” to better model diagnoses and develop targeted neuromodulatory treatments

- **Hypothesis:** Individuals who develop PCS and chronic pain after a motor vehicle accident (MVA) will present increases in absolute power particularly across low-frequency bands
  - representing an overall slowing of the brain



Clinical Utility

fMRI

VS

qEEG

Concussions in Canada

Canadian Community Health Survey (2011)

- Estimated 98, 440 annual head injuries (2.4% of population)

- Adolescents = 22, 720 (23%)
- Adults = 55, 910 (57%)
- Seniors = 19, 810 (20%)

Ontario Neurotrauma Foundation (2014)

- 10% of people under 18
- 1.8% of adults 18-30
- .08% of adults 31-65
- 3.9% of adults over 65
- More than 500, 000 Canadians living with concussion

Activity-limiting brain injuries 2009-2010 (Statistics Canada, 2011)
Ontario Neuro Trauma Foundation Annual Report (2014)

Methods

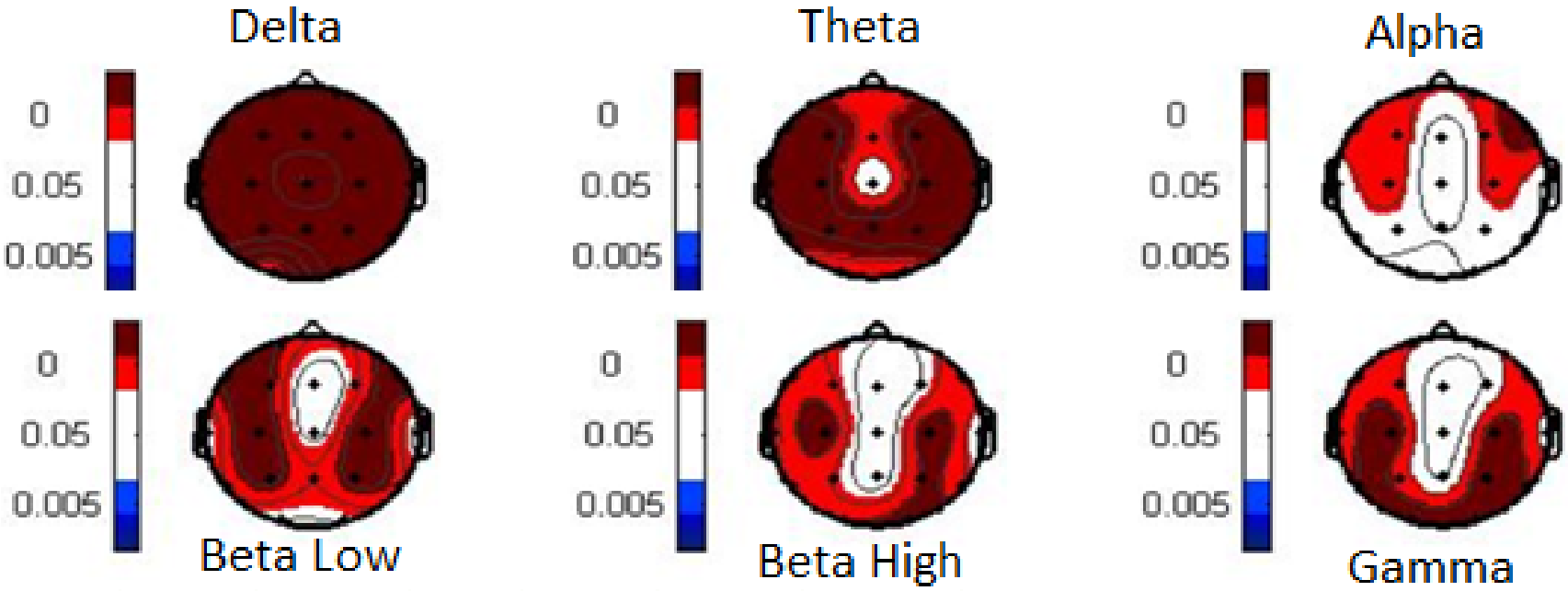
- Retrospective case-control study using eyes open resting state EEG data
- 57 patients (mean age 44.6, 21 male, 36 female) with chronic pain and PCS following motor vehicle accidents
- 54 healthy controls matched closely for age and sex (mean age 43.5, 16 male, 38 female).
- The data was collected using 19 electrodes positioned via the standard EEG 10-20 system and analyzed using MATLAB and SPSS.

Results

- Independent Mann-Whitney U tests revealed significant increases in global spectral power across all frequency bands of the patient group when compared to the control group ($p<0.05$ corrected) with delta being most prominent

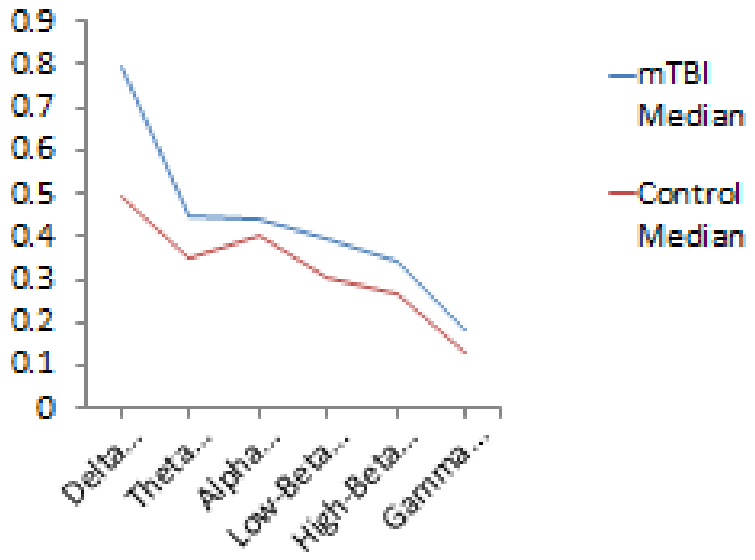
- Relative delta power increases and alpha decreases were also significant. Moderate correlations were found between the duration of PCS+Pain and increases in absolute power.

Absolute Power: Patient Minus Control

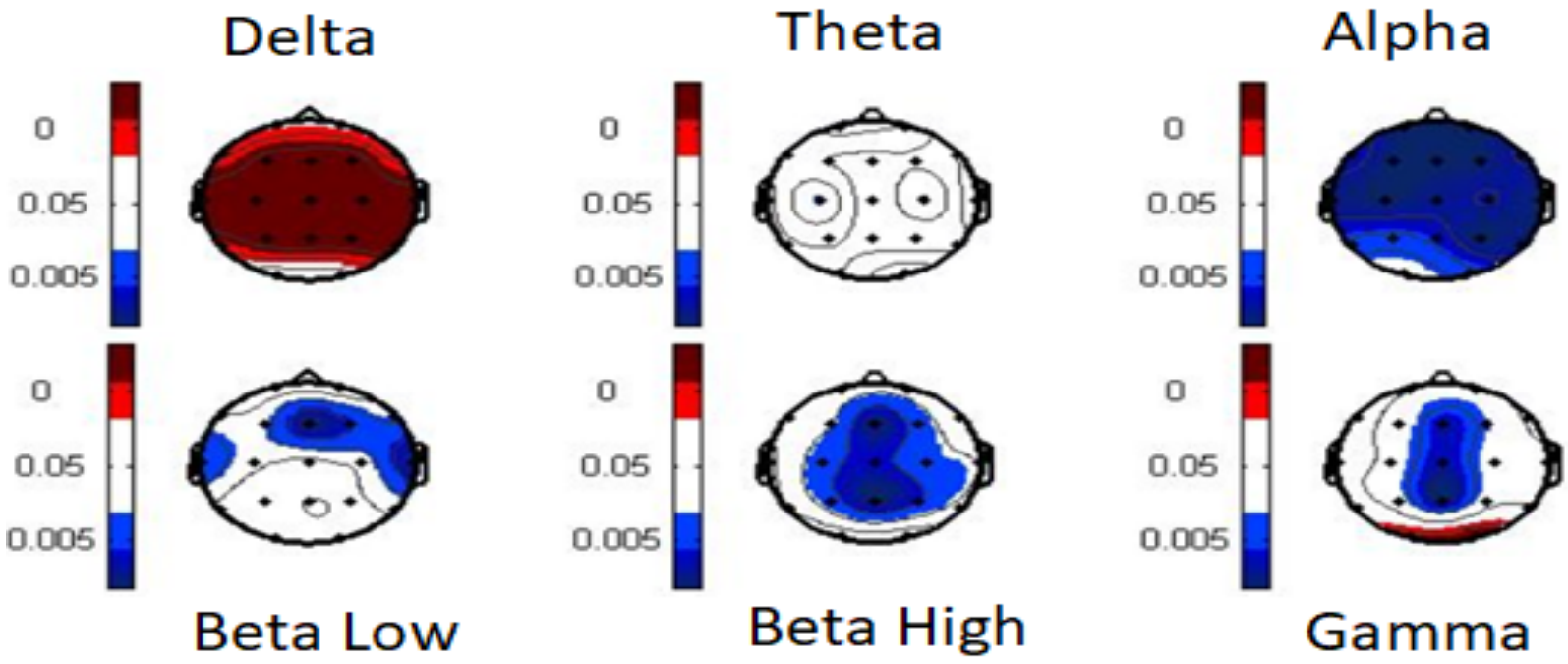


Power	mTBI Median	Control Median	mTBI SD	Control SD	R Value	P Value
Delta	0.793	0.490	0.355	0.130	0.346	0.000000
Theta	0.451	0.346	0.178	0.114	0.311	0.000030
Alpha	0.437	0.399	0.204	0.162	0.317	0.028606
BetaLow	0.396	0.306	0.173	0.112	0.320	0.002332
BetaHigh	0.344	0.269	0.152	0.122	0.059	0.005759
Gamma	0.180	0.131	0.087	0.069	-0.059	0.002621

Note: This table summarizes the median and standard deviation of the patient and control groups' absolute power, as well as the results from absolute power comparisons between patients and controls using independent Mann-Whitney U tests and a correlation of duration with power.



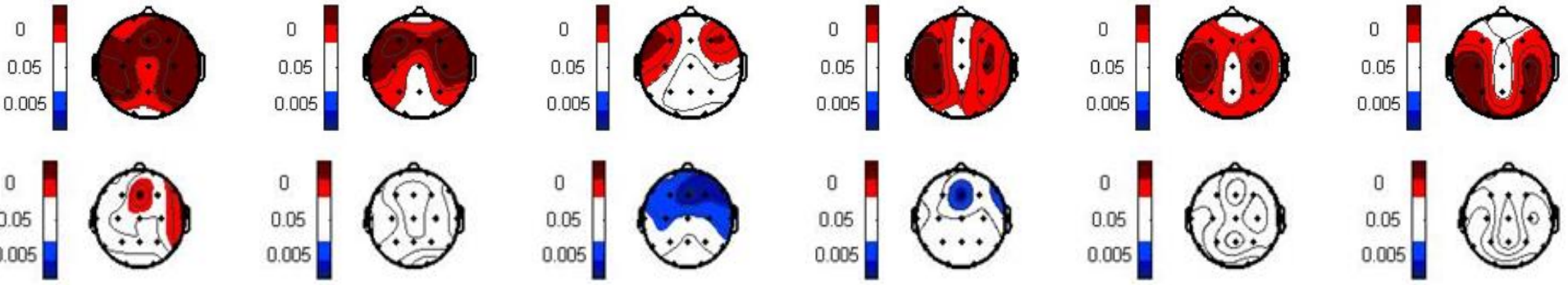
Relative Power: Patient Minus Control



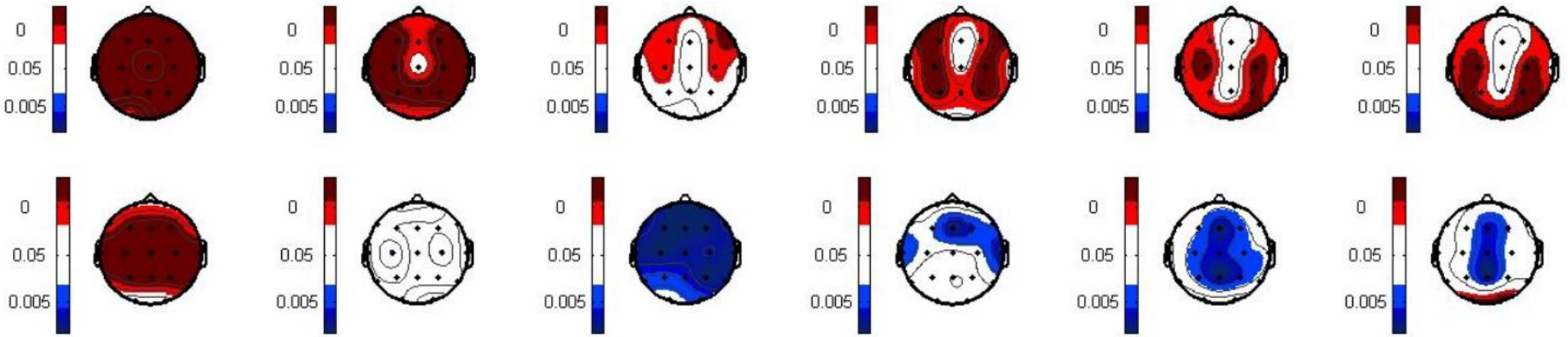
Relative Power	mTBI Median	Control Median	mTBI SD	Control SD	P Value
Delta	0.300	0.252	0.052	0.037	0.000006
Theta	0.179	0.181	0.020	0.019	0.745562
Alpha	0.171	0.185	0.034	0.038	0.000500
BetaLow	0.148	0.159	0.023	0.021	0.066523
BetaHigh	0.129	0.137	0.031	0.031	0.076730
Gamma	0.063	0.659	0.022	0.018	0.772507

Replication of findings

2016 Cohort



2018 Cohort



Conclusion

- The present study provides further evidence for the potential clinical usefulness of qEEG biomarkers such as absolute/relative power and functional connectivity

- The incremental goal of our research program is to identify biomarkers specific to PCS independent of chronic pain, and vice versa, to help clinically differentiate between these co-morbid conditions

- These biomarkers are a precursor to a more dynamic clinical model that will be used to guide neuromodulatory treatments