Changes in Brain Network Organization in Children and Adolescents with Sports Related Concussion: 1 Year Follow Up
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OBJECTIVES
1. To evaluate changes in resting state functional brain networks in individuals with sports related concussion using graph theory over a 1 year time span.
2. To evaluate whether children and adolescents differ in their pattern of recovery during this time frame.

METHODS
Participants:
15 concussed adolescent athletes participated in the study (ages: 9-19, average age 12.93).

Control groups:
• First time point contains 16 athletes (ages: 9-19, average age 12.54)
• Final time point contains two groups:
  1. Control +1 year: a 1-year follow up with the above control participants (n=5)
  2. Baseline +1 year: the baseline resting state EEG of a different group of healthy adolescents that is one year older than the initial time point of the concussed group (n=13, ages: 10-20, average age: 13.69).

Electroencephalography (EEG) protocol:
Resting state EEG data was collected for both concussed and control samples for 5 minutes (with eyes closed) using a 64-channel Hydrogel Geodesic SensorNets (EGI, Eugene, OR).

RESULTS

Changes in Clustering Coefficient and Betweenness at different time points:

Average Number of Symptoms and Severity of Symptoms decreased at 1 month after concussion:

Trajectory of recovery in athletes with single concussion is different from those with multiple concussion in F10:

Trajectory of recovery in children (ages 9-13) and adolescents (ages 14-19):

SCAT-3 Assessment:
Total number of symptoms and symptom severity score were obtained from the Sport Concussion Assessment Tool (SCAT).

CONCLUSIONS
• Network analysis shows significant changes in connectivity in different regions following a concussion. Re-organization of the functional network is evident from 1 week post-concussion to 1 year post-concussion.
• Adolescents with multiple concussions are slower to recover compared to adolescents with a single concussion in the (R)-PFC.
• Adolescents (14-19 y/o) appear to have larger changes in connectivity in comparison with the children in the (L) frontal regions.
• Symptoms and Symptom Severity Scores decrease from 1 month post-concussion.

REFERENCES

Graph Theory image by: Angela Muller

Betweenness centrality: The fraction of all shortest paths in the network that contain a given node. Nodes with high betweenness centrality participate in a large number of shortest paths.

Clustering coefficient: The fraction of triangles around a node and is equivalent to the fraction of node’s neighbors that are neighbors of each other.

Average Number of Symptoms and Severity of Symptoms decreased at 1 month after concussion:

* Significant difference between 1 month and 3 months and 3 months and 12 months time points. CC in Fpz was significantly lower at the 3 month and increased by 12 months post injury.

* Significant difference between 1 week post-concussion and control group. Betweenness values in F10 were significantly higher 1 week post injury.

* Significant difference between the two groups at 3 months

* Significant difference between the two groups at 1 month. Betweenness at F9 was significantly lower in the older group.