

Cognitive and Physical Deficits Secondary to High G-Force Centrifuge Training

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History

- 29 year old male military aerospace contractor with a chief complaint of headache after high g-force centrifuge training (up to 9Gs) where he passed out after reaching 6 g.
- No head trauma or whiplash.
- Upon regaining consciousness, patient had nausea, vomiting, headache, altered mental status and memory loss, and dark spots in the central vision.
- Head CT 60 minutes after blacking out was negative.
- He was hospitalized for two nights and received brain MRI with contrast, EEG, and ophthalmic exam, which were negative.
- The patient was seen 7 days after the event by our clinic and reported continual 2/10 frontal and occipital headaches, increased irritability, and difficulty concentrating with mental tasks.
- SCAT5 score was 88.



Fig 1. 20 G Centrifuge at NASA Ames Research Center

Physical Exam

- General: Well appearing adult male in good physical condition.
- HEENT: Head atraumatic. No phorias, tropias, or nystagmus. Normal fundoscopic exam.
- Neuro: CNII-XII intact. No weakness
- Vestibular/ocular-motor: symptomatic smooth pursuit and saccadic eye movements. Asymptomatic visual motor sensitivity test. Near point convergence was borderline abnormal at 7 cm with left sided accommodative spasm. Cover uncover test revealed mild left sided esophoria.

Differential Diagnosis

- Concussion, repetitive head injury syndrome, somatic symptom disorder, seizure disorder, cardiogenic syncope, stroke.

Studies and Results

- IMPACT cognitive testing scores: All within normative data.
- Visual testing: King-Devick Cards: I: 10.12s II: 9.47s III: 11.84s (total time: 31.43s; within normal limits).
- Exercise testing: Maximum linear exertion tolerated without symptoms on the BCBT.
- Vestibular testing: Force plate sway velocity 0.7 deg/s (within normative data) with mild right midline shift. (see fig 2)

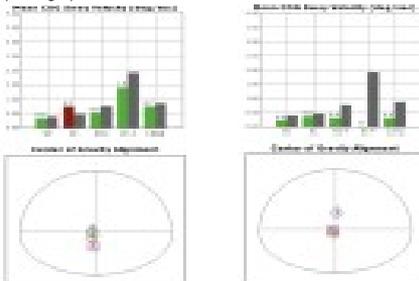


Fig 2. Patient's initial and improved force plate

- qEEG- abnormal P300 Evoked response potentials (ERPs) and excessive frontal alpha. (see figs 3-4)



Fig 3. qEEG Brain Map low P300 and excessive frontal alpha



Fig 4. P300 Table

Oscillating oculomotor tracking test results:

Increased microsaccades magnitude, mild saccadic and pursuit dysfunction with unteaming, and convergence insufficiency. (see figs 5-7)



Fig 5: Convergence insufficiency

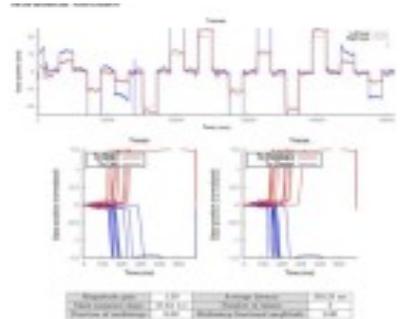


Fig 6 Saccadic dysfunction

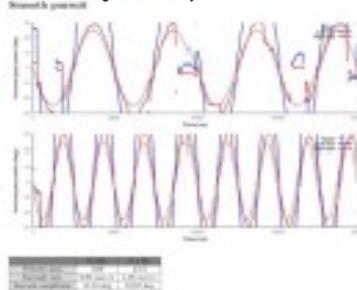


Fig 7. pursuit dysfunction.

Working Diagnosis/Treatment

- Patient's workup consistent with concussion.
- He was given work/visual restrictions in accordance using the Individualized Cognitive Action Plan as well as exercise/exertional restrictions in accordance with Active Rehab Protocol for Traumatic Brain Injury.

Discussion

- Although rare, spinning, without head trauma, can cause concussions.
- Guskiewicz et al. showed that concussions can occur at g-forces of 60-168 g in football players.
- Our patient, experienced prolonged g-forces for many seconds vs the shorter but greater force sustained from football injuries.
- Dr. Wang demonstrated that figure skaters were able to reach 2-Gs during spinning which resulted in headache and nausea without concussion. This suggests that a spin of sufficient g-force, over time might result in a concussion or concussion-like syndrome. We propose that this mechanism may be the cause of our patient's symptoms.

Outcome/Return to Work

- Follow up at 17 days revealed near complete resolution of symptoms with only 1/10 headache and minor difficulty concentrating.
- SCAT5 score was 4, decreased from 88.
- He had returned to work on a full time basis with visual accommodations and extra breaks
- At two month follow up, patient was asymptomatic and cleared to do 4 g as fighter jet passenger but not cleared for return to centrifuge.
- At 5 months, he remained asymptomatic but continued to show abnormalities on ERPs and vision testing and was cautioned against centrifuge. Patient opted to retire from centrifuge training.