Mild Traumatic Brain Injury: Vestibular Consequences

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Mild Traumatic Brain Injury

- 19.5% of all those deploying to Iraq or Afghanistan suffer mTBI (Rand Corporation July 2008, DCoE March 2009)
- Recent theatre work indicates that over 90% of patients with acute mTBI will have vestibular disorders
- Vestibular disorders are present in over 80% of those with chronic mTBI

Vestibular Work-Up for Chronic mTBI

- Specialized vestibular history and physical
  - Characterization of injury
  - Standard history questions
  - Otolaryngologic and Neurologic Physical exam
- Evaluation by a physician, a physical therapist, and an audiologist
- Evaluation captured in a computer program (AHLTA)

Evaluation - continued

- Audiogram
- Neuro-vestibular testing
- Standardized assessment instruments

Details available upon request

Blunt Trauma mTBI: Chronic Balance Disorders

Entity	History	Physical Exam	Vestibular Tests
Positional Vertigo	Positional Vertigo	Nystagmus on Dix-Hallpike test or modified Dix-Hallpike test	No other abnormalities
Exertional Dizziness	Dizziness during and right after exercise	Abnormalities in challenged gait testing	No other abnormalities
Migraine Associated Dizziness	▪ Episodic Vertigo with periods of unsteadiness ▪ Headaches	▪ Abnormalities in challenged gait testing ▪ +/-Abnormalities on head impulse testing ▪ Normal static posture tests	▪ VOR gain, phase, or symmetry abnormalities ▪ High frequency VOR abnormalities ▪ Normal posturography
Spatial Disorientation	▪ Constant feeling of unsteadiness worsened by standing but still present when sitting or lying down ▪ Drifting to one side while walking ▪ Shifting weight when standing still	▪ Abnormalities on standard gait tests ▪ +/- Abnormalities on head impulse testing ▪ Abnormalities on static posture tests	▪ VOR gain, phase, or symmetry abnormalities ▪ High frequency VOR abnormalities ▪ Abnormal posturography ▪ Central findings on rotation chair testing

Blast Trauma mTBI: Chronic Balance Disorders

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Positional Vertigo	Positional Vertigo	Nystagmus on Dix-Hallpike test or modified Dix-Hallpike test	No other abnormalities
Exertional Dizziness	Dizziness during and right after exercise	Abnormalities in challenged gait test	No other abnormalities
Blast induced Disequilibrium	▪Constant feeling of unsteadiness when standing and walking worse with challenging environments ▪Constant Headache	▪Abnormalities in challenged gait ▪Abnormalities in tandem Romberg ▪Abnormalities with quick head motion	▪+/- VOR gain, phase, or symmetry abnormalities ▪Abnormal posturography ▪Abnormal target acquisition, dynamic visual acuity, and gaze stabilization
Blast induced Disequilibrium with Vertigo	▪Constant feeling of unsteadiness when standing and walking; worse with challenging environments ▪Constant Headache ▪Episodic Vertigo	▪Abnormalities in challenged gait ▪Abnormalities in tandem Romberg ▪Abnormalities with quick head motion	▪VOR gain, phase, or symmetry abnormalities ▪Abnormal posturography ▪Abnormal target acquisition, dynamic visual acuity, and gaze stabilization

Chronic Balance and Vestibular Disorders: Summary

- Blunt mTBI
  - Episodic vertigo or unsteadiness with episodic headache
  - Post-traumatic migraine associated dizziness
- Blast mTBI
  - Constant unsteadiness and headache
  - Both exacerbated by challenging environments (lighting, surface, exertion, etc.)

Chronic Vestibular Disorders: Treatment

- Control Headaches
  - Pharmaceuticals
  - Try to limit use to 8 weeks because compliance is a major issue with young people
- Vestibular Rehabilitation
  - Try to organize as best as possible around training schedule
  - Close to home therapy is ideal

Chronic Vestibular Disorders – Pharmaceuticals

- (Vestibular) migraine: preventative medicines
  - Topiramate - 100-125 mg po qhs (reached after gradual build-up over 4 weeks).
  - Verapamil – 180 mg SR tablet PO q day
  - Nortryptilline – 50 mg po qhs
  - Others – Low dose Neurotin, SSRI
- Migraine abortive medicines
  - Triptans – some evidence to support superiority of Maxalt

Chronic Vestibular Disorders: Rehabilitation

- Requires detailed assessment by vestibular physical therapist and an individualized treatment plan
- Exercises target VOR abnormalities, VSR abnormalities, and dynamic balance disorders

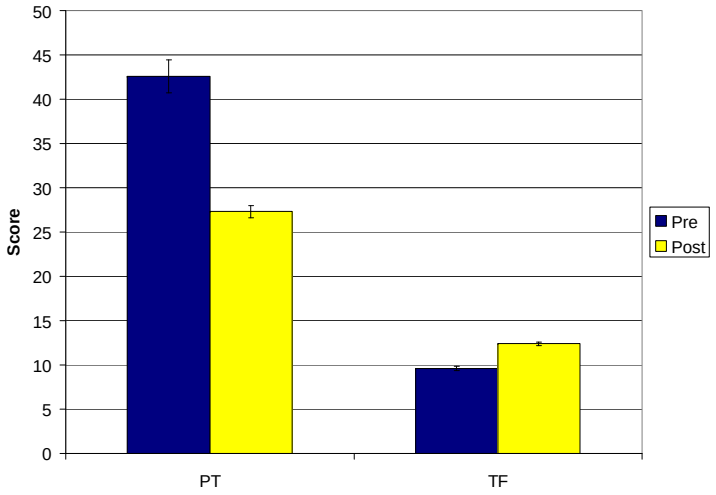
Results of Combined Therapy

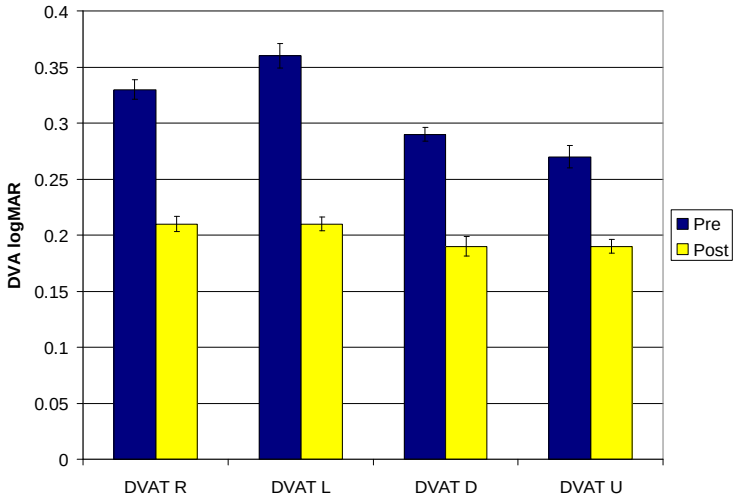
- 82 consecutive war injured patients underwent combined pharmaceutical and vestibular rehabilitation for 8 weeks
  - 79 males, 3 females
  - Average age 24.0 years of age (19-34)
- Outcome of therapy measured using the inVision Mirror Tunnel (NeuroCom International, Clackamas, OR, USA

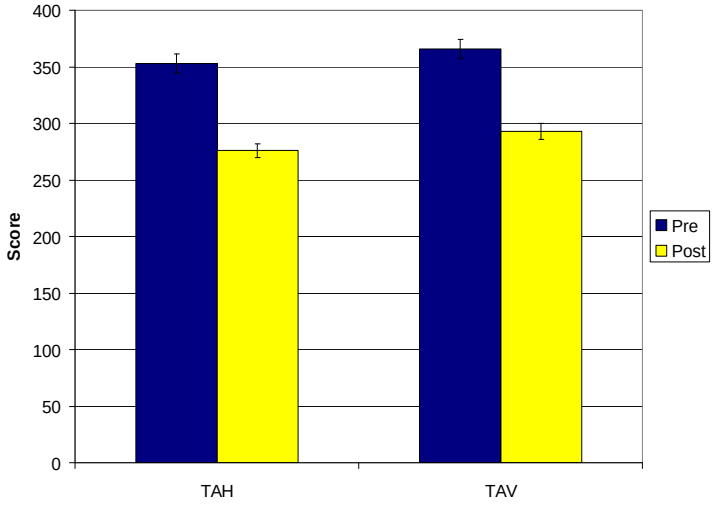
Materials and Methods

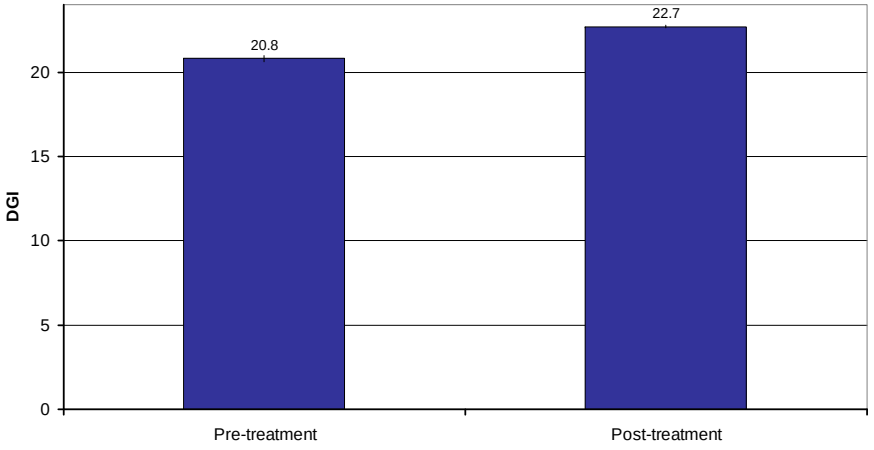
- Test Battery
  - Perception Time
  - Target Following
  - Target Acquisition Test
  - Dynamic Visual Acuity (DVAT)
  - Gaze Stabilization (GST)
  - Dynamic Gait index

Results – Perception Time (PT), Target Following (TF), Dynamic Visual Acuity (DVA), Target Acquisition (TA), Dynamic Gait Index (DGI)









Acute mTBI after Blast: Vestibular Consequences

- 85% of individuals in a vehicle where one individual feels the blast wave will have mTBI associated balance disorders
- Acute blast induced mTBI
  - Over 90%have a balance disorders
    - Objective VOR abnormality
    - Disordered Dynamic Gait
    - Expressed as unsteadiness (worse in challenging environments which are common in an operational setting)

Acute mTBI after Blast: Vestibular Treatment Strategies

- Early intervention strategy
  - Recent observations suggest that beginning pharmaceutical therapy and rehabilitation within 24 hours eliminates vestibular symptoms at 7 days in ~70% of patients
  - PRIORITY: confirm findings with multi-center, multi-service study in the CENTCOM AOR
    - Group already assembled to develop this study

Acute mTBI after Blast: The Future

- What happens to the brain after blast exposure?
- Friedlander wave in brain case
  - Rodent experiments with low exposure
    - Vascular wound healing mRNA expression pattern
    - Histological evidence: brain and inner ear
      - Brain parenchyma normal
      - Vascular and neuronal changes in protein expression
  - Hypothesis
    - Primary vascular injury → repair and inflammation →altered vascular autoregulatory capacity
    - Acute susceptibility to secondary oxidative stress?

Acute mTBI after Blast: Toward Future Countermeasures

- Double blind, placebo controlled study of N-acetylcysteine (NAC) for acute mTBI almost complete
  - Standard therapy with/without NAC
  - Time of treatment initiation (<24 hr vs. >30 hr)
- Must transition basic science solutions to troops as soon as possible

Conclusion

- Vestibular disorders are the most common manifestations of mTBI in our patient population
  - Consider as ‘sentinel finding’ for Blast-induced mTBI
- Almost one in five patients who deploy will suffer mTBI and most will have balance disorders
- Best strategy to prevent long term disability
  - Early intervention (Study in progress)
  - Countermeasures given immediately after the blast to prevent sequelae (possibly antioxidant or HBOT)