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Balance Disorders after Closed Head Injury

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Outline

- **Ear/Balance System as Shock Organs**
- **Examination of the Balance System**
- **Balance Disorders from CHI**
 - Ear related disorders
 - Closed Head Injury
 - Other Considerations



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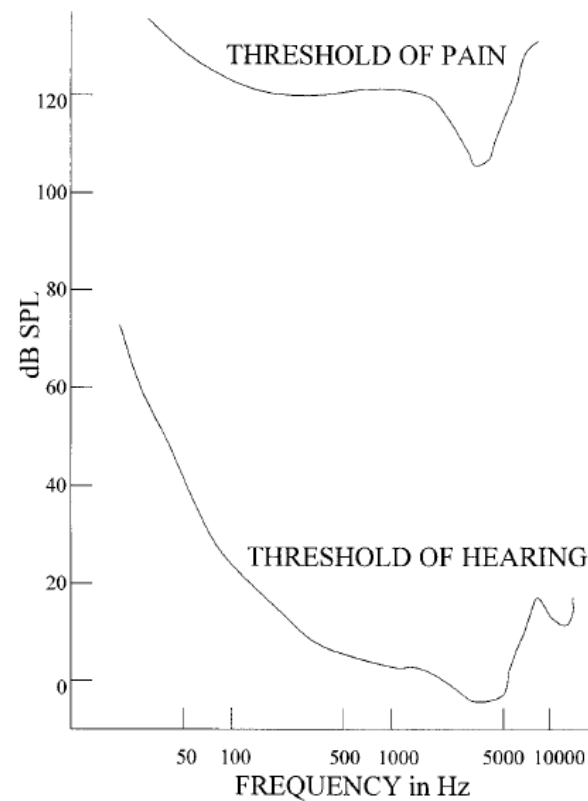
Background

- 2006 CDC
 - 1.5 million annually with TBI, 80% mild, 2% disability
- Military Population
 - 2-3x higher rates of CHI in peacetime
- TBI common battlefield injury
- DSM IV TR
 - physical symptoms for dx of post-concussive disorder-fatigue, disordered sleep, headaches, and ***vertigo/dizziness***



Ear as Shock Organ

- Ear = mechano-electric transducer
 - 12 Orders of Magnitude
 - 0 dB is one twenty-millionth of Pascal
 - 10^{-8} cm movement at the tympanic membrane
- Blast = Pascal's
 - Force transmitted to neuroepithelium
- TM rupture as “pressure sensor”
 - The response of the human ear to blast. Part 1: The effect on the ear drum of a short duration, fast rising pressure wave. Army Weapons Research Establishment/Chemical Defense Establishment Report 1982;No. 04/82.
 - Experimental pressure induced rupture of the tympanic membrane in man. Acta Otolaryngol 1993;113:62-7.





Balance Disorders related to TBI

- VA/DoD CPG mTBI Management
 - Treatment of somatic complaints should be based upon individual factors and symptom presentation
- Terrio 2009
 - Dizziness/Balance problems common and persistent after mTBI
 - Persistent through deployment 6% dizzy, 15% imbalance
 - In some persisted after deployment
 - For 25-37% new symptoms developed after deployment

Traumatic brain injury screening: preliminary findings in a US Army Brigade Combat Team. J Head Trauma Rehabil 2009;24:14-23.
- Dizziness/Balance Disorders common from Head Trauma
 - Balance as a vital combat sense
 - Evolves/Changes over time after injury

Blast Exposure vestibular consequences and associated characteristics
Otol Neurotol. 2010 Feb;31(2):232-6.

 - Not one disorder



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The Balance “System”

- Ears
 - Linear and angular accelerometers
- Eyes
 - Reflex arcs, fast response, 30ms
- Joints/Muscles
 - Receptors for position, spine reflexes
- CNS
 - Integration of inputs, “perception”



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Balance Examination

- Subset of neurologic exam
 - Reflexes, highly reliable if abnormal
 - Correlate to audiologic tests
 - Exam builds to higher integration abilities
- Ears
 - TM integrity
 - Tuning forks
 - Fistula Test
- Eyes
 - Nystagmus, gaze, smooth pursuit



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Balance Examination

- Evoked Nystagmus-VOR
 - Halpike
 - Halmaygi Head Thrust
 - Post Head Shake
- VSR
 - Romberg



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Balance Examination

- Central Integration-Active Motion
 - Dynamic Visual Acuity
 - Museum gait
 - Dynamic Gait Index
 - Good intra-rater reliability
- Screening History
 - Dizziness Handicap Index

Objective vestibular tests as outcome measures in head injury patients Laryngoscope. 2003 Oct;113(10):1746-50



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Balance Disorders - CHI

- Ear Related Disorders
- Closed Head Injury Disorders
- Others



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Otologic Causes: Post Traumatic Dizziness

- Less common, relatively easy to identify
 - Labrynthine concussion, TB fx, PLF
- Standardized History and Physical Examination
 - Limited reliance on specialized testing-
Audiogram
 - Hx
 - Duration, frequency, precipitating factors
 - PE
 - Nystagmus, Otoscopy, tuning forks, Hallpike, Rhomberg



Dizziness after CHI: Blunt

- Classification
 - >400 patients before 2002
- Four Groups
 - Post-traumatic positional vertigo
 - Post-traumatic exertional dizziness
 - Post-traumatic migraine associated dizziness (PTMAD)
 - Post-traumatic spatial disorientation

Characterizing and Treating Dizziness after Mild Head Trauma.
Otol/Neurotol, 25(2);135-38, 2004.



Dizziness after CHI: Blunt

- BPPV
 - Hx, position provoked episodic vertigo
 - PE, positive Dix-Halpike with nystagmus
 - Geotropic rotatory-Anterior or Posterior Canal
 - Horizontal beating-Lateral canal
 - All other exams and tests normal



Dizziness after CHI: Blunt

- Exertional Dizziness
 - Hx, Dizziness/unsteadiness during or right after exercise, +/- Headache
 - PE, abnormal challenged gait testing
 - Testing-Normal



Dizziness after CHI: Blunt

- Migraine Associated Dizziness
 - Hx, Episodic vertigo short and multiple
 - Typical IHC Migraine-not with vertigo
 - PE, abnormal challenged gait, normal static posture
 - Testing, +/- VOR abnormalities, normal Posturography

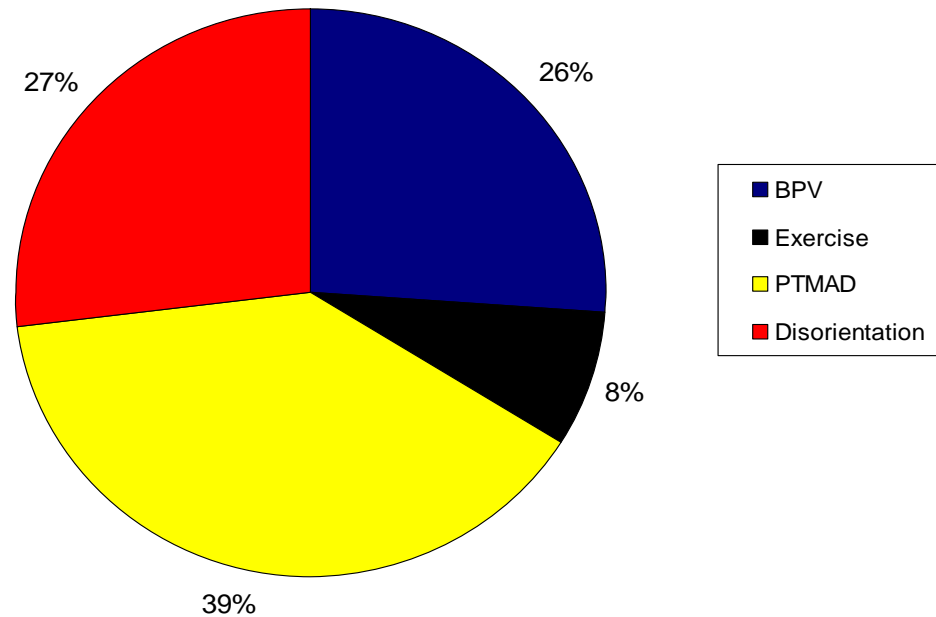


Dizziness after CHI: Blunt

- Spatial Disorientation
 - Hx, constant unsteadiness, worse when standing still (present sitting-lying down)
 - PE, abnormal static posture, abnormal challenged gait, abnormal DVA
 - Testing, poor posturography, Abnormal VOR

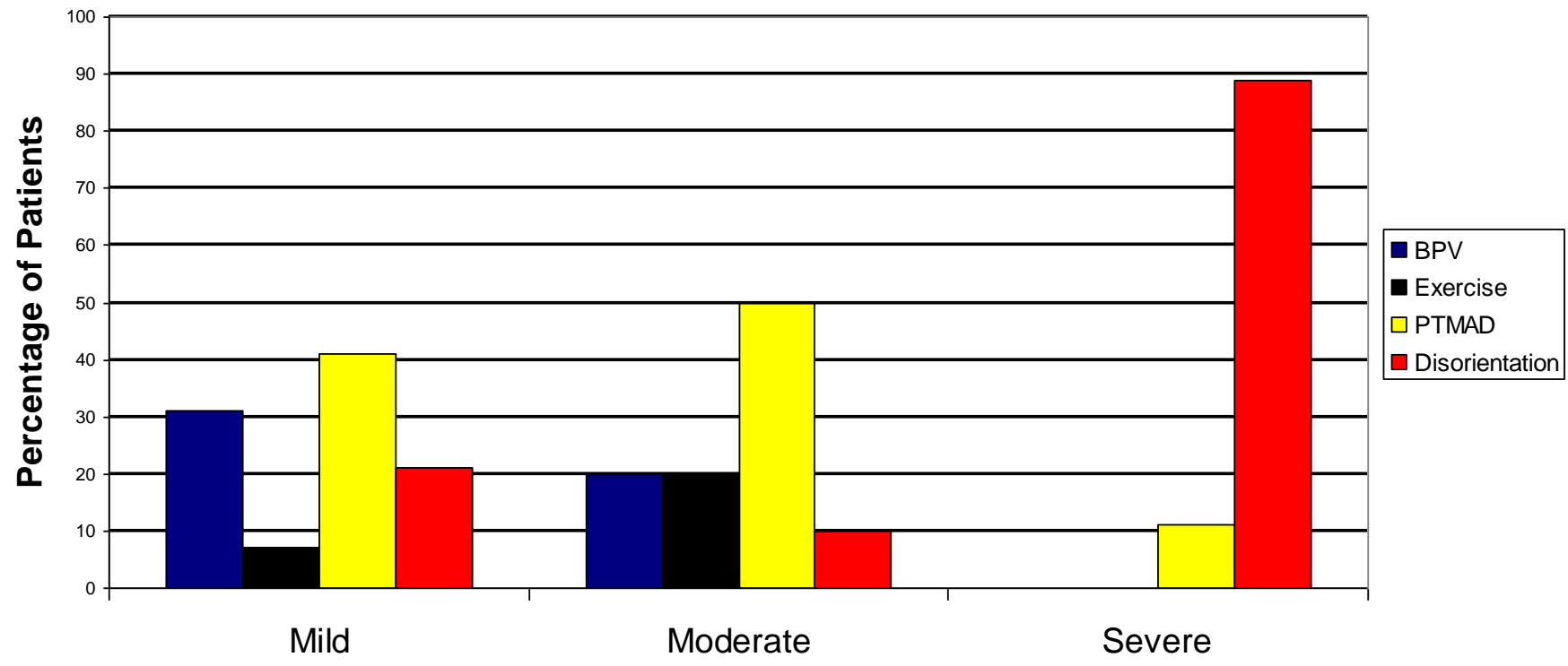


Dizziness after CHI: Blunt





Dizziness after CHI: Relationship to Severity



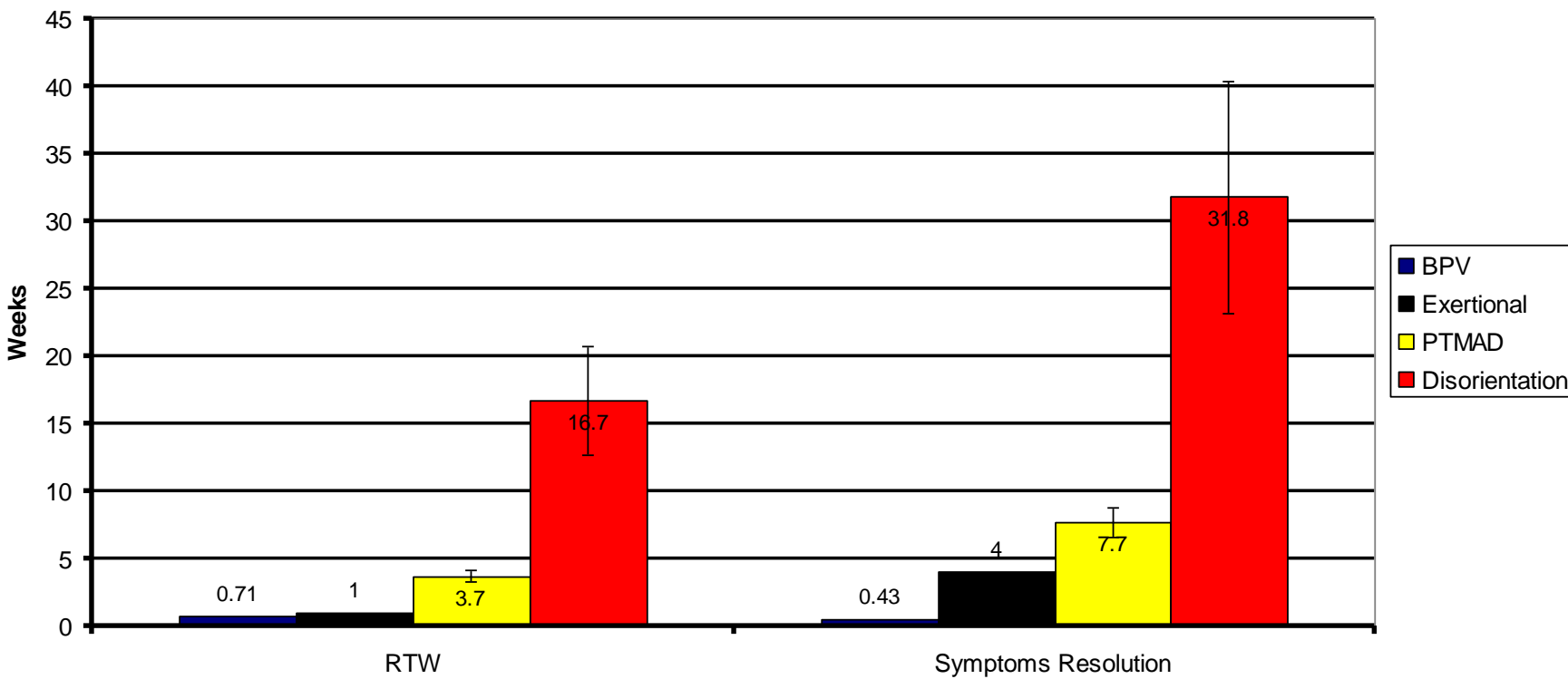


Dizziness after CHI: Blunt

- Treatment
 - BPPV:
 - Canalith repositioning maneuver
 - Exercised Induced Dizziness:
 - Vestibular Rehabilitation
 - MAD:
 - Migraine Prophylactic,
 - Vest Rehab prn
 - Spatial Disorientation:
 - Vestibular Rehab



Dizziness After CHI: Blunt Treatment Response





Dizziness after CHI: Blast

- DCOE Meeting May 2009
 - Non-Impact Blast-induced mTBI
 - Variety of scientific data now supports difference from Blunt trauma related mTBI
- Established Dizziness patterns
 - Began changing 2003-2004
 - “new” diagnostic groups for blast

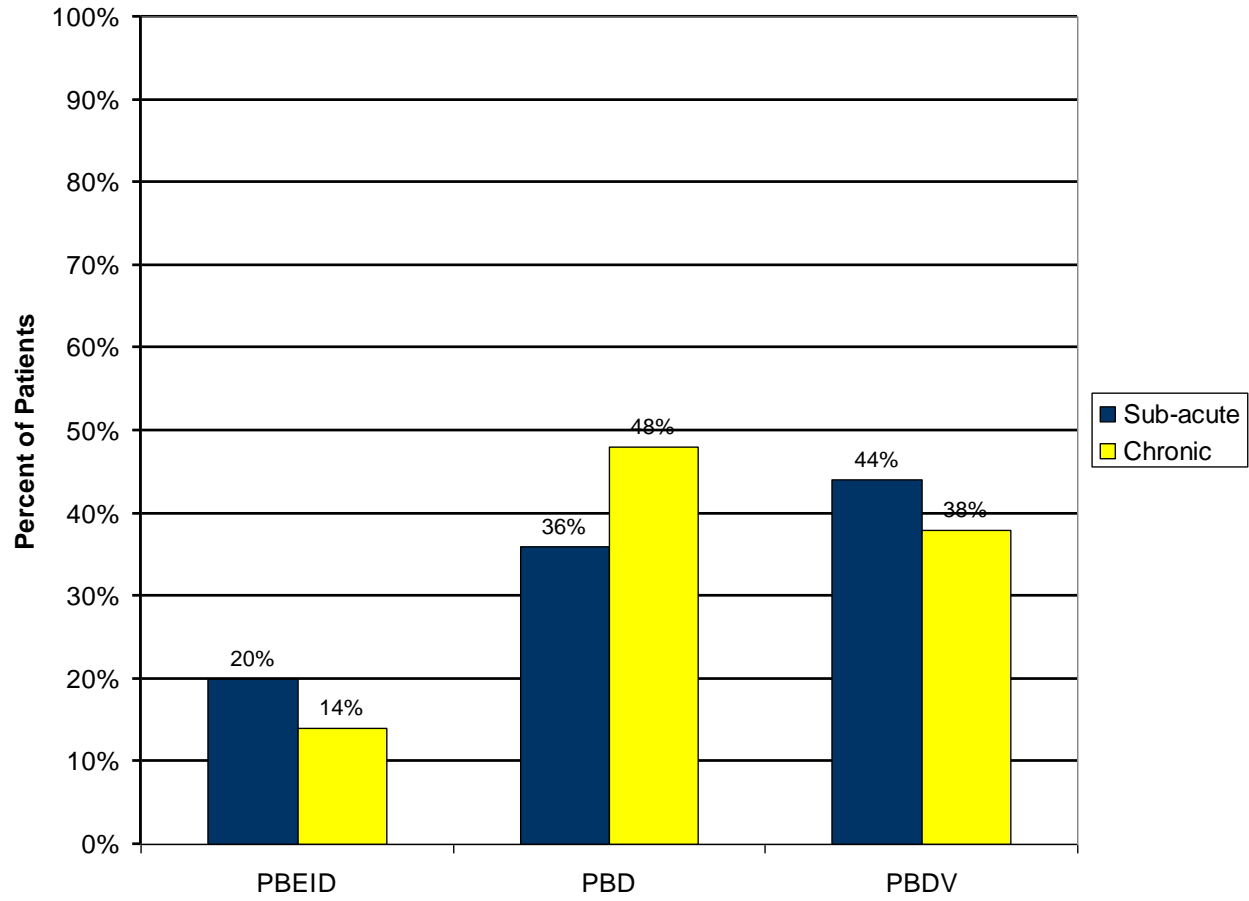


Dizziness after CHI: Blast

- 200 patients after 2004: Blast CHI
 - Post Blast Exercised Induced Dizziness
 - Post Blast Dizziness
 - Hx, Constant feeling of unsteadiness when standing and walking worse with challenging environments, Constant Headache
 - PE, Abnormalities in challenged gait, tandem Romberg, DVA
 - Testing, Abnormal Posturography, VOR and visual testing
 - Post Blast Dizziness with Vertigo
 - As above but also with episodic vertigo



Dizziness after CHI: Blast





Dizziness after CHI: Blast

- Dizziness and headaches are among the dominant symptoms of mTBI seen after blast
- Balance disorders can be classified in sub-acute and chronic blast exposure patients
- Objective vestibular tests tend to worsen over time
- Concurrent PTSD Dx grows at a high rate
- Delayed ELH!



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PT-MAD

- If Migraine prophylactics help-which one?
 - Retrospective, 72 patients
 - Dx Migraine, ICHD-2, vertigo
 - Male, 24, blast or blunt trauma
 - Verapamil, Topiramate, Gabapentin, Amitryptiline

Prognostic Assessments of Medical Therapy and Vestibular Testing in Migraine Associated Dizziness OTO HNS 2010 DEC 143 (6)820-825



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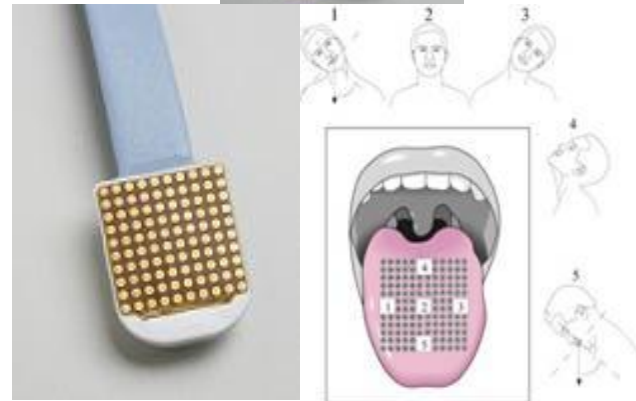
PT-MAD

- No Difference in responders to non-responders in any drug
- Predictive of Success
 - Initial response ($P < 0.001$)
 - Final DGI, DVAT ($P < 0.01$)
- Predictive of Failure
 - Quetiapine ($P < 0.01$)



Treating Failures

- Standard treatment effective for most patients
 - What to do rescue failures?
- Sensory Substitution
 - WICAB,
 - Florida IHMC
- 11 Patients (17)
 - 9 blast TBI





Results

Patient	Age	Etiology	SOT-Pre	SOT-Post	DGI-Pre	DGI-Post
1	26	IED Blast	26	80*	21	21
2	44	IED Blast	44	74*	24	24
3	37	IED Blast	51	65*	18	24
4	28	IED Blast	60	63	20	24
5	24	IED Blast	36	67*	21	24
6	30	Oscillopsia	69	81*	17	24
7	49	Chemotherapy	62	56	20	20
8	46	Blunt CHI	49	39*	20	16
9	23	IED Blast	68	32*	22	22
10	33	Blunt/Blast	60	91*	21	23
11	25	IED Blast	42	48	20	24

Bold: Normalized SOT; *Italic:* Improvement without normalization; * Significant change



Results

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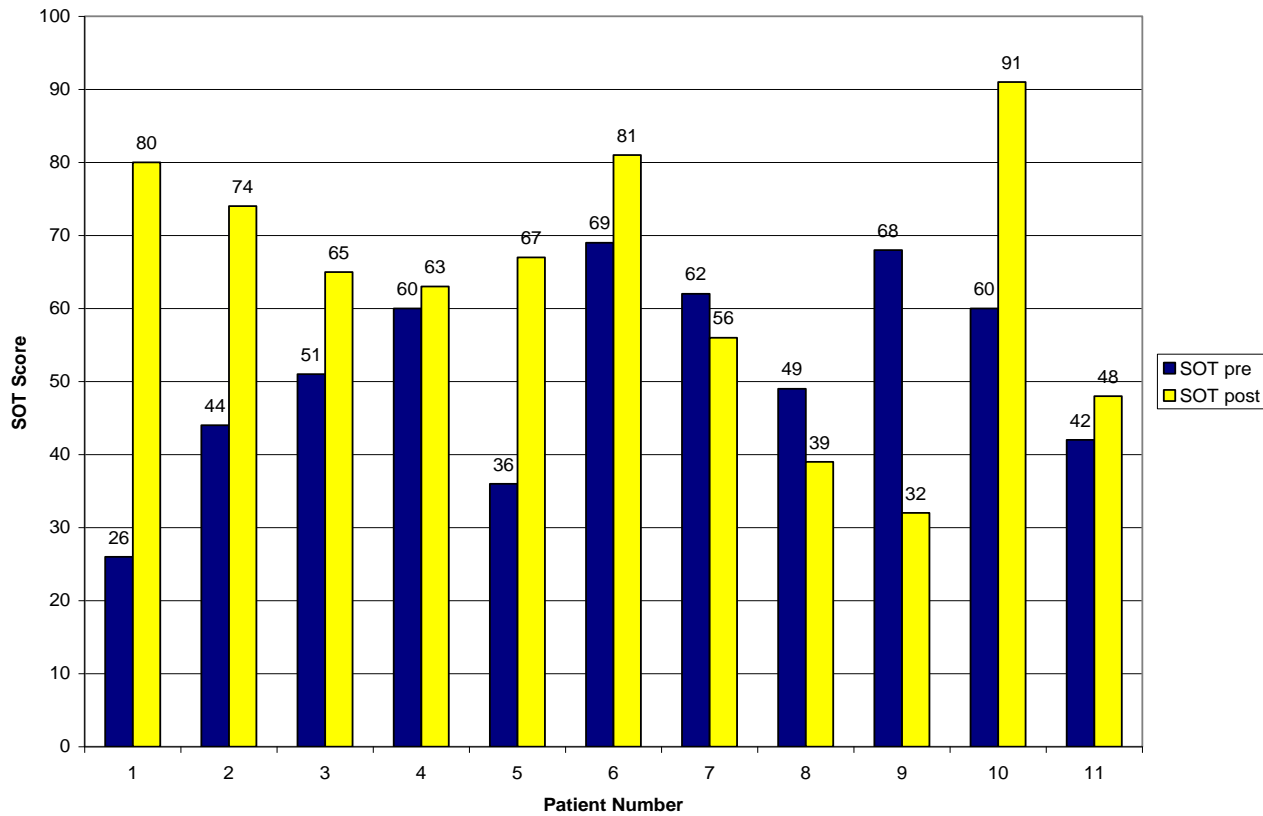
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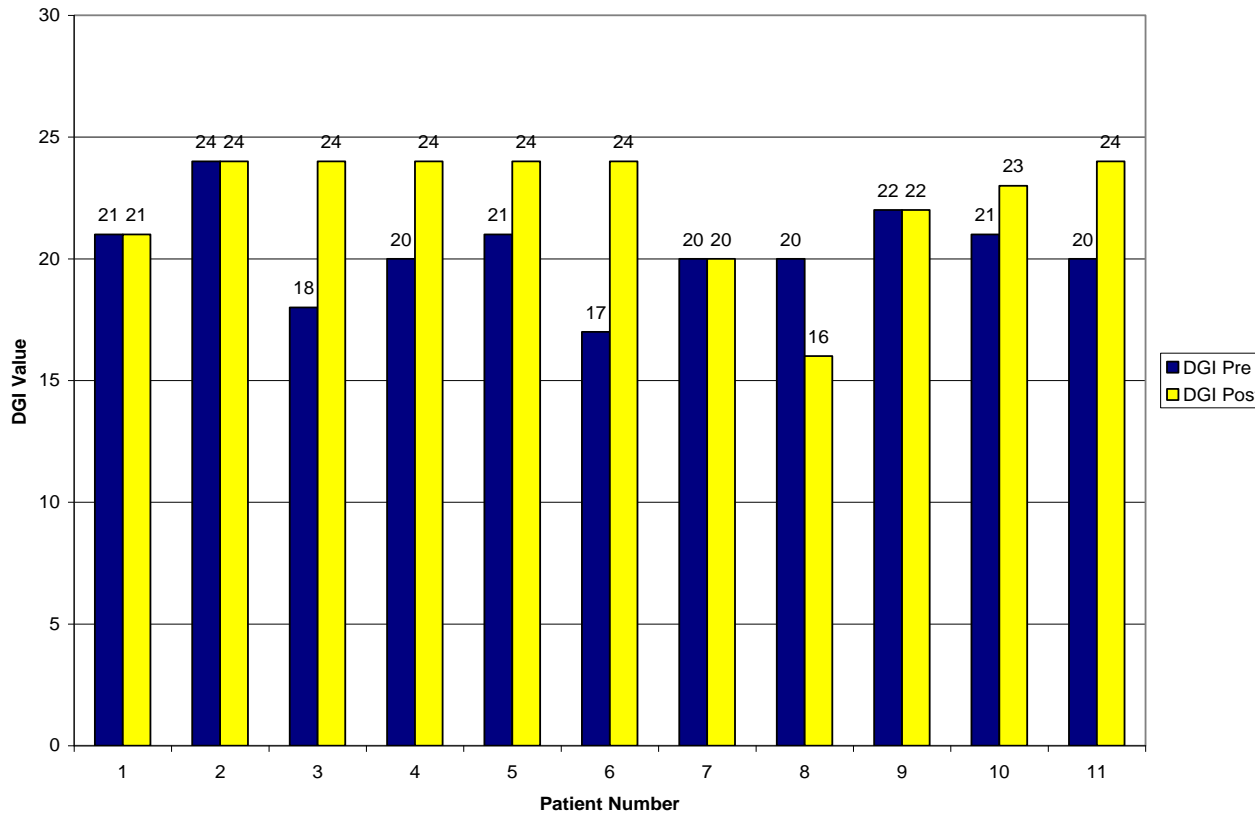


Sensory Substitution: SOT





Sensory Substitution: DGI





Chronic Subjective Dizziness

- Common cause of chronic dizziness in civilian populations
- Symptoms are psychological in nature (anxiety, depression)
- Can give abnormal objective testing results

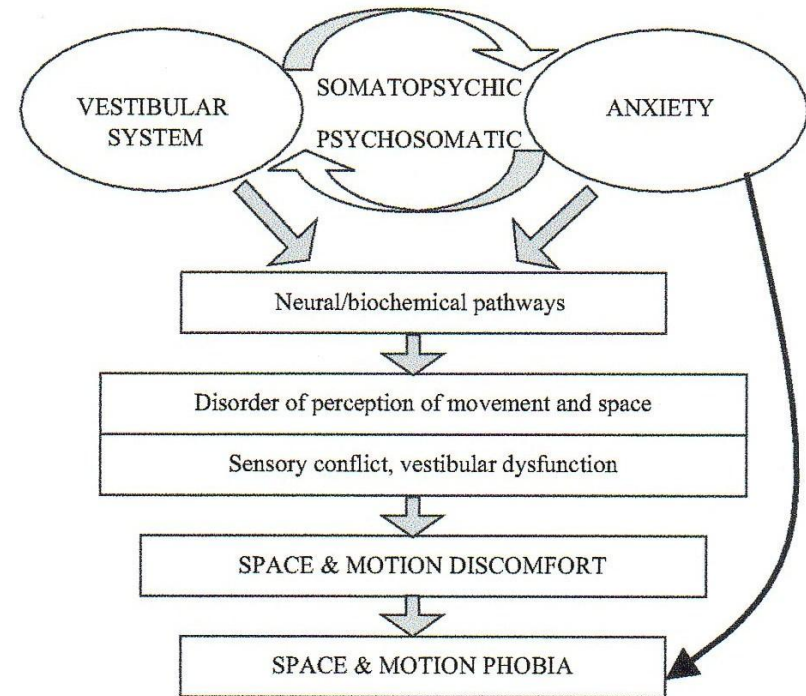
Chronic dizziness: the interface between psychiatry and neuro-otology
Curr Opin Neurol. 2006 Feb;19(1):41-8

Chronic Subjective Dizziness: Acta Oto-Laryngologica, 2008; 128: 10851088



Chronic Subjective Dizziness

- Links “physiology” with “psychology”
- Balance as Perception
- Underscores need to indentify and treat early before becomes “chronic”





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Summary

- Balance
 - Critical Sense, disorders common after TBI
- Disorders can be classified
 - Exam, diagnosis, prognosis
 - Blast seems to be worse
 - ?co-morbidities/medications
- Early evaluation and management may lead to better outcomes



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Questions?



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- **BACKUPS**



Dizziness after CHI: Blast

- Classification
 - 200 patients after 2004
- Four Groups
 - Post-traumatic positional vertigo
 - Post Blast Exercised Induced Dizziness
 - Post Blast Dizziness
 - Post Blast Dizziness with vertigo



Dizziness after CHI: Blast

Group	Dizziness	Vertigo	Hearing Loss	Headache	PTSD
Acute	98%*	4%*	33%*	72%	2%*
Sub-acute	76%	47%	43%	76%	20%
Chronic	84%	36%	49%	82%	44%