POSTUROGRAPHY

WG CDR RENU RAJGURU, PROFESSOR, AFMC

Introduction

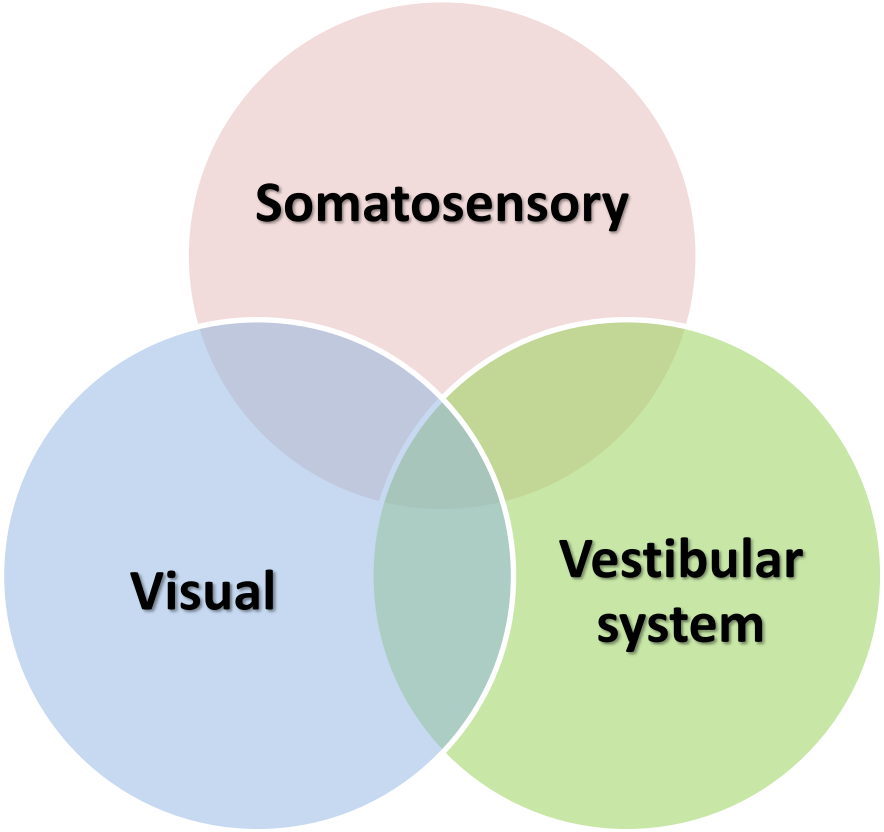
- Posture: static relative position of different body parts with respect to each other

Ageing
Neurological
Visual
Vestibular
Orthopedic disorders

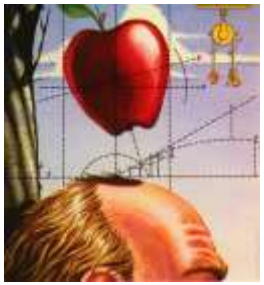
Postural instability

Introduction

Principle Sensory systems in Balance mechanism:



BALANCE

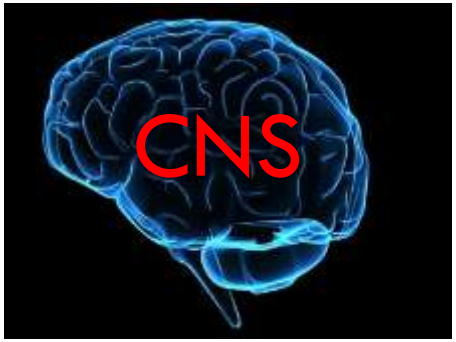


graviceptors

vision

Vestibular organ

proprioception



Gaze stabilization

Orientation and navigation

Balanced locomotion

Autonomic function

Circadian rhythm

POSTUROGRAPHY

- Objective techniques used to quantify **postural control in upright stance in** individuals
- Most sensitive technology for balance evaluation*
- Functional measure
- Isolates functional contributions of sensory inputs

* Black FO. Clinical status of computerized dynamic posturography in neurotology. *Current Opinion in Otolaryngology & Head and Neck Surgery* 2001; **9**(5): 314-8.

POSTUROGRAPHY

STATIC

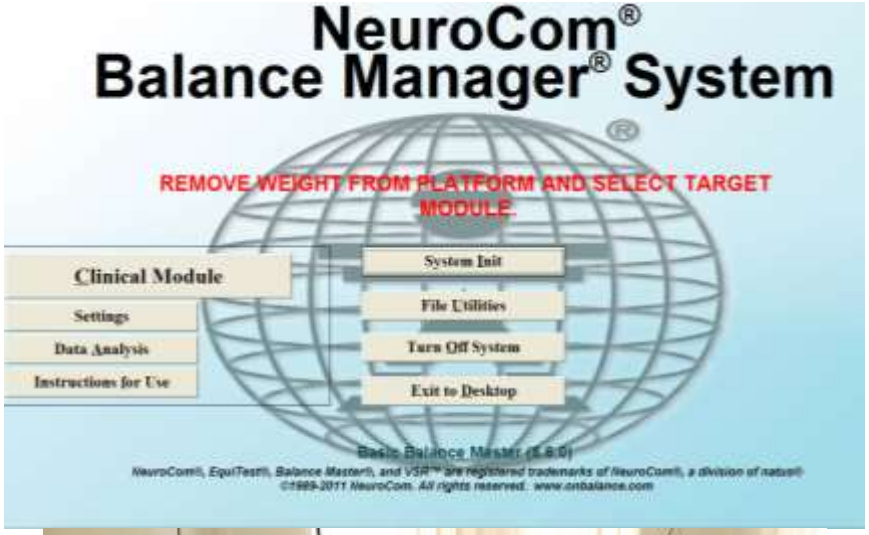
Subjects maintain stance in a relatively unperturbed state (usually quiet stance on a fixed support surface).

DYNAMIC

Experimentally induced balance perturbations

COMPUTERISED STATIC POSTUROGRAPHY

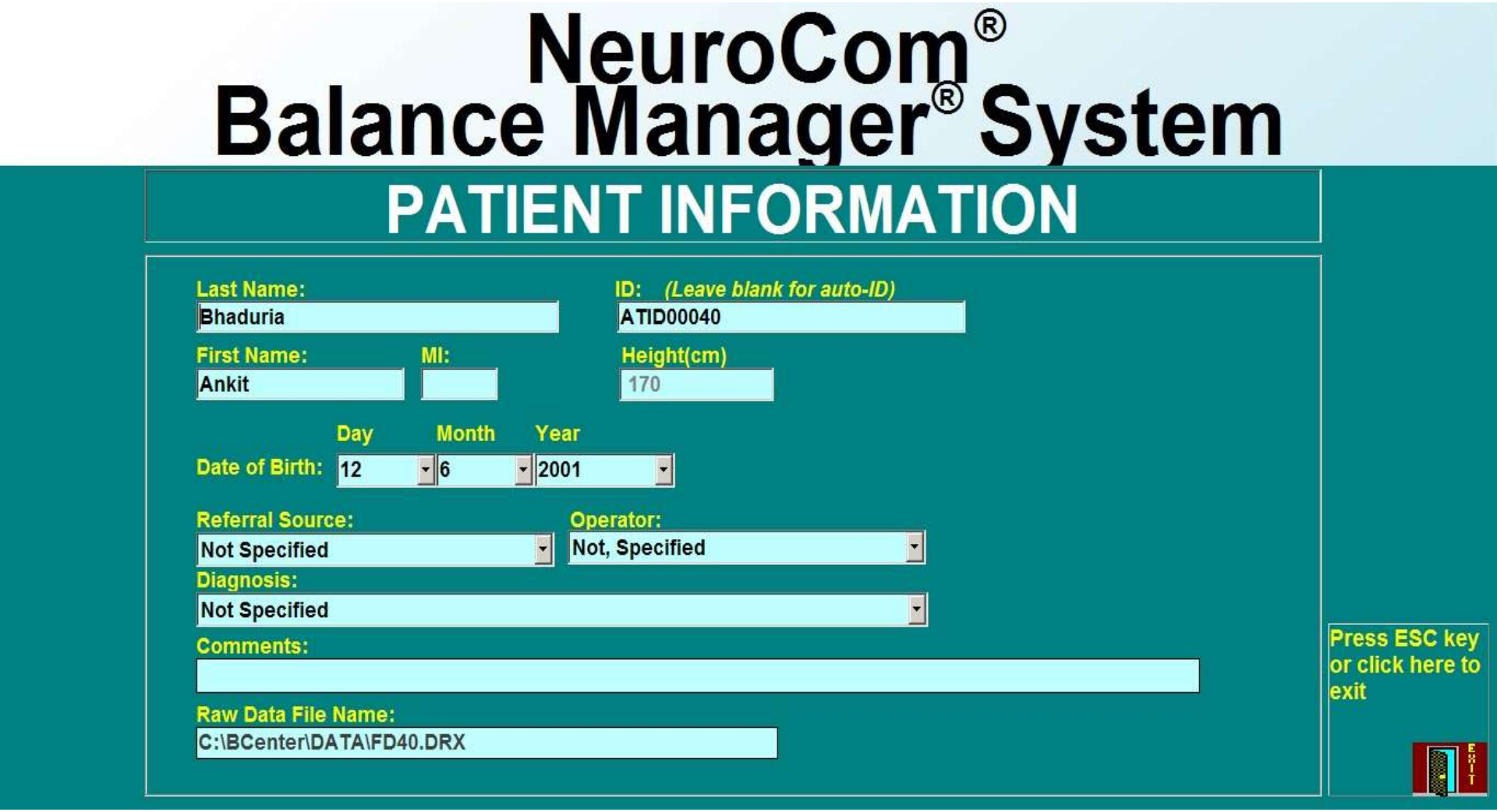
Neurocom balance Master



Static Posturography

- **Modified Clinical Test of Sensory Interaction and Balance**
- **Limits of Stability**
- **Rythmic Weight Shift**

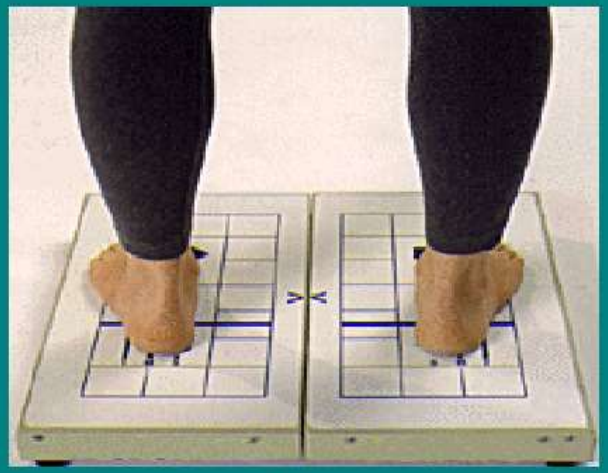
Modified Clinical Test of Sensory Interaction and Balance



Modified Clinical Test of Sensory Interaction and Balance

Modified CTSIB

Align medial malleolus to center horizontal line and lateral calcaneous to 'T' line.



1	2	3	1	2	3	1	2	3	1	2	3
EO-FIRM(1)			EC-FIRM(2)			EO-FOAM(3)			EC-FOAM(4)		

Trial 1, Eyes Open, Firm Surface

Click on Start button to begin test.

Start | Next Test | Assessment Menu | Main Menu

mCTSIB test conditions

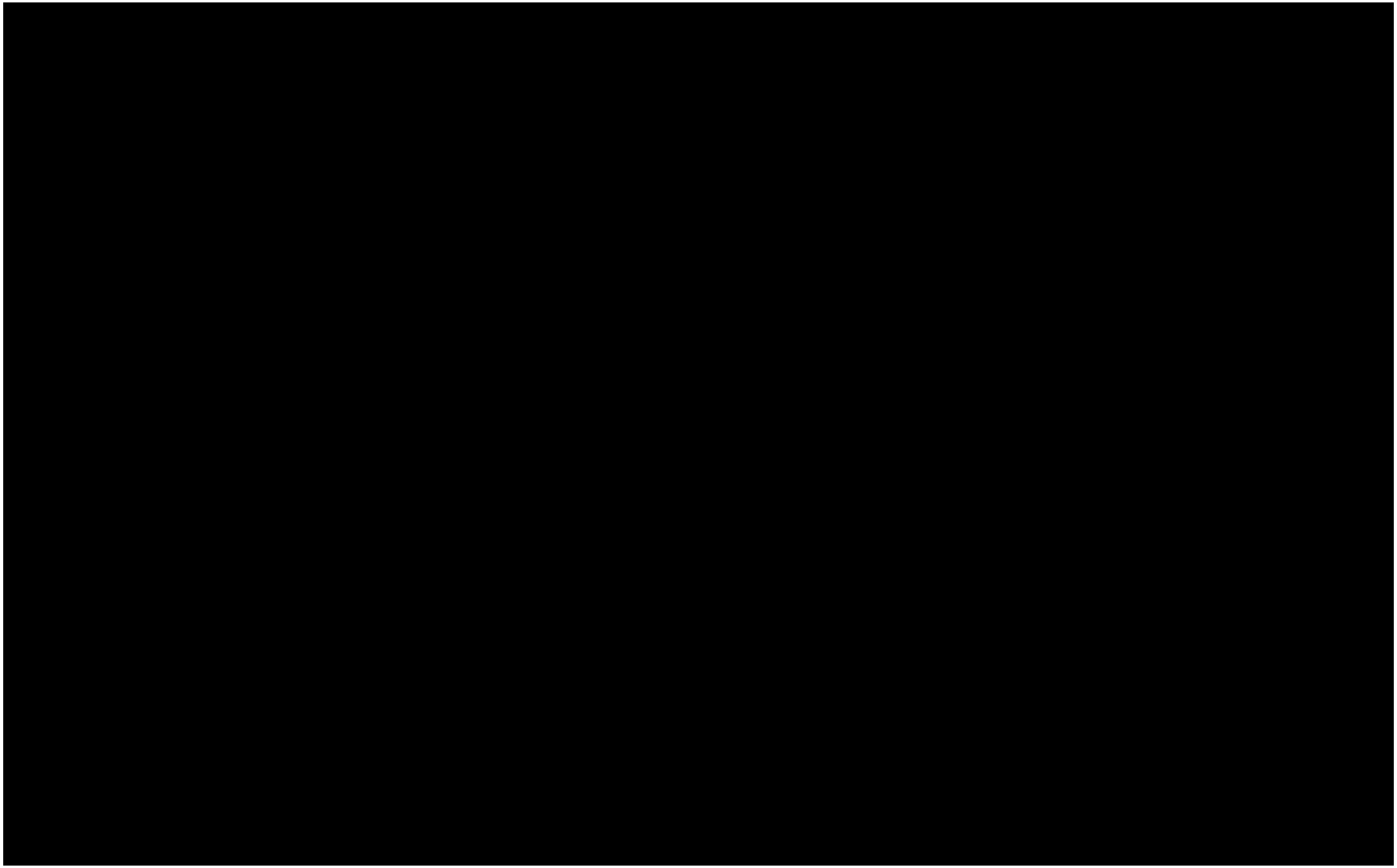
EO-Firm

EC-Firm

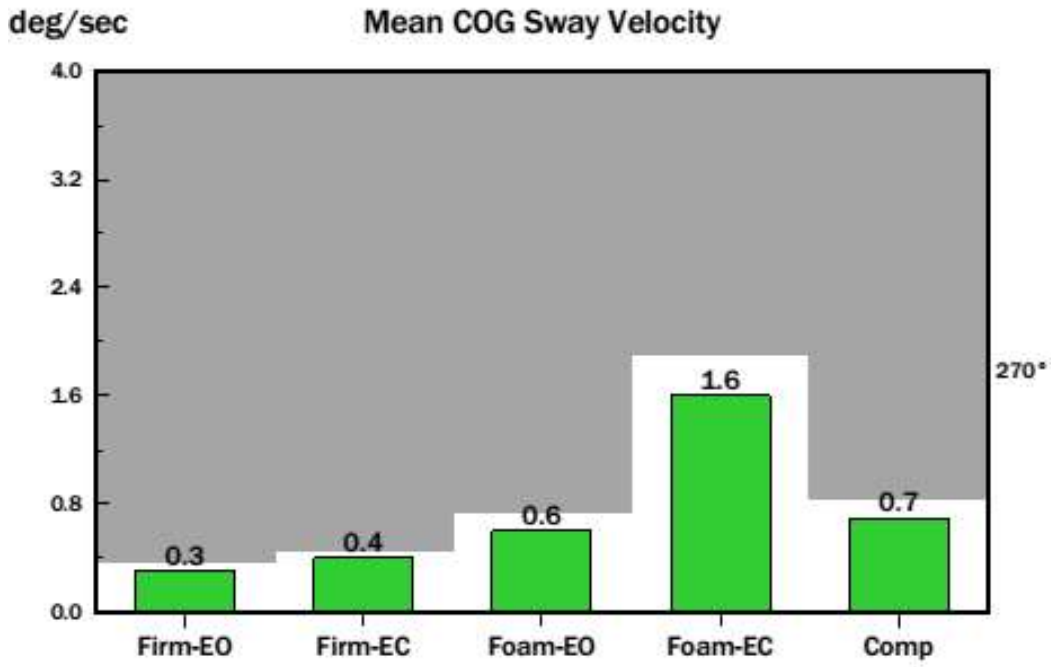
EO-Foam

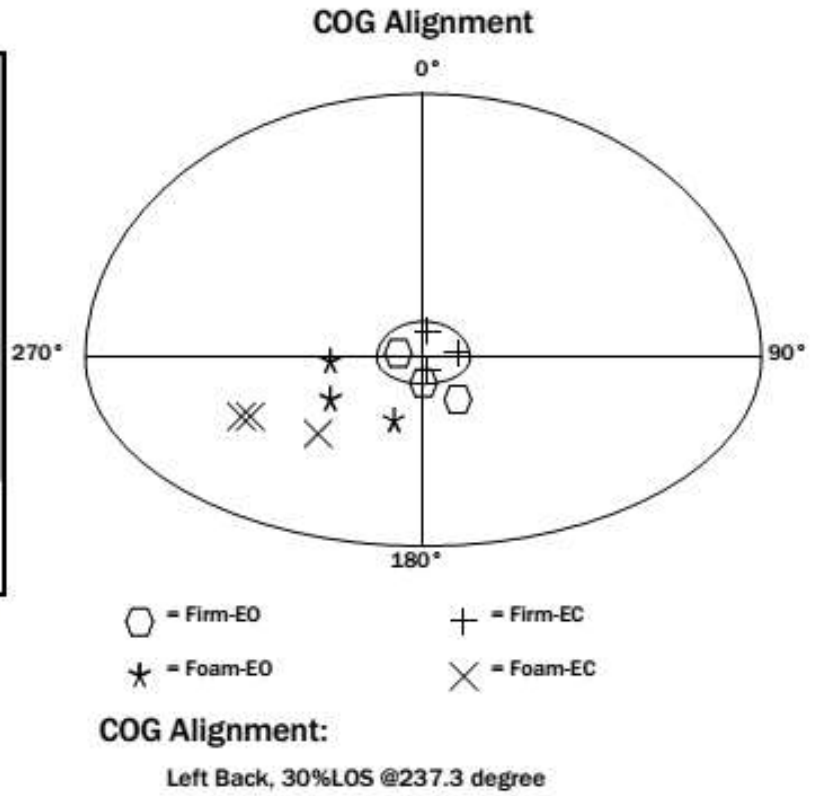
EC-Foam

mCTSIB test



mCTSIB - Results

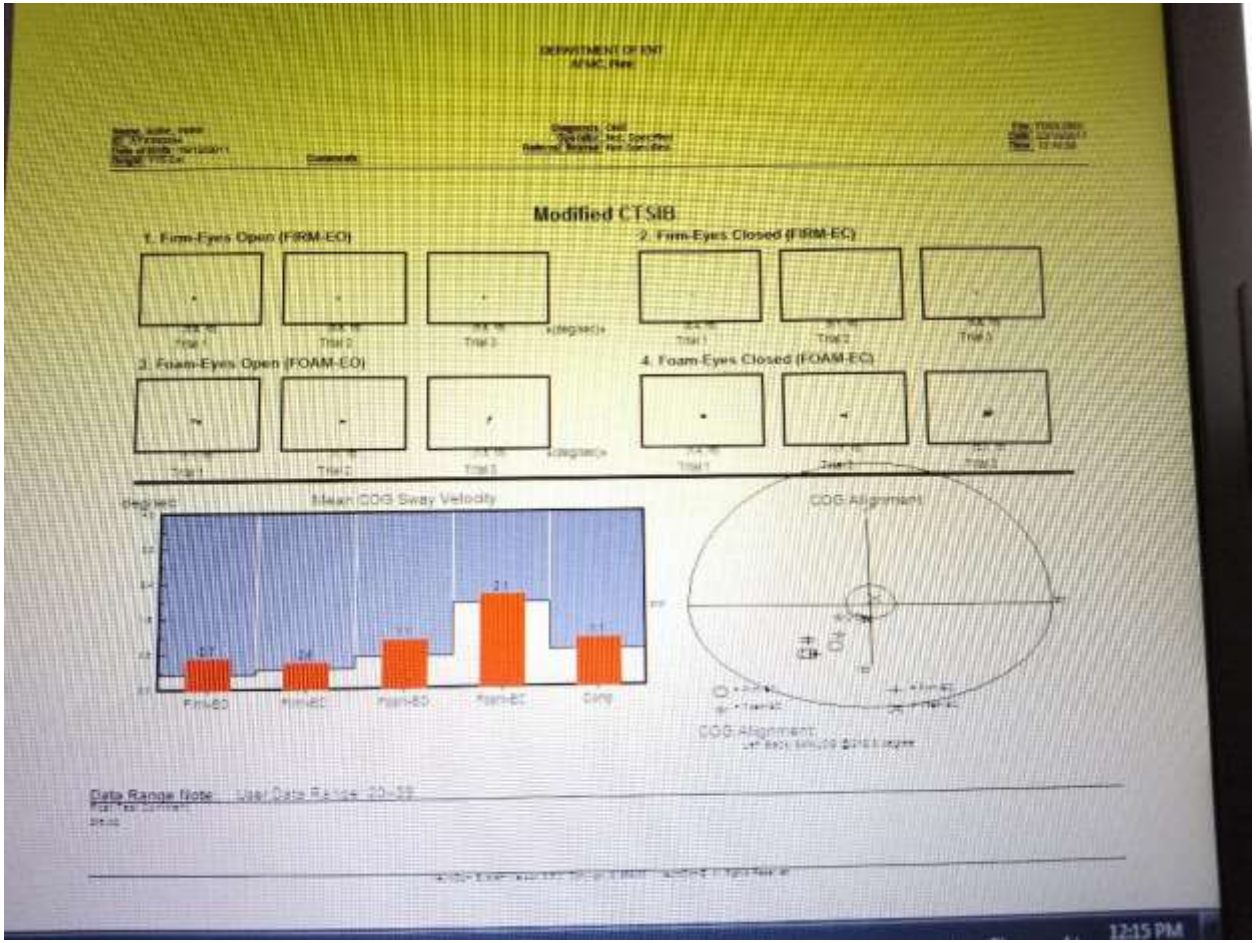




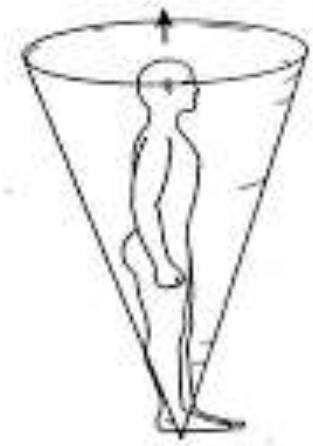
COG Alignment:

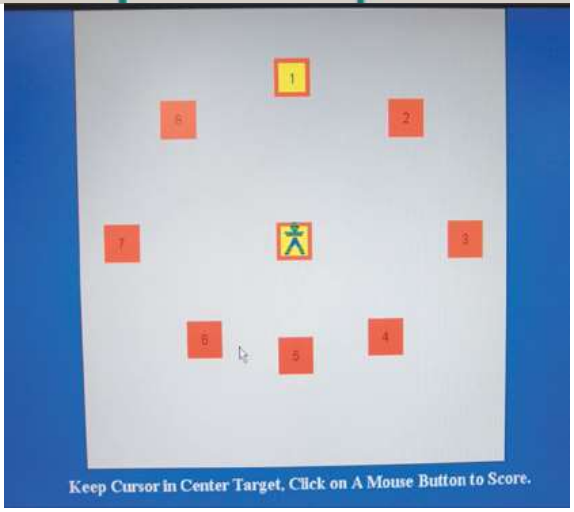
Left Back, 30%LOS @237.3 degree

mCTSIB - Results

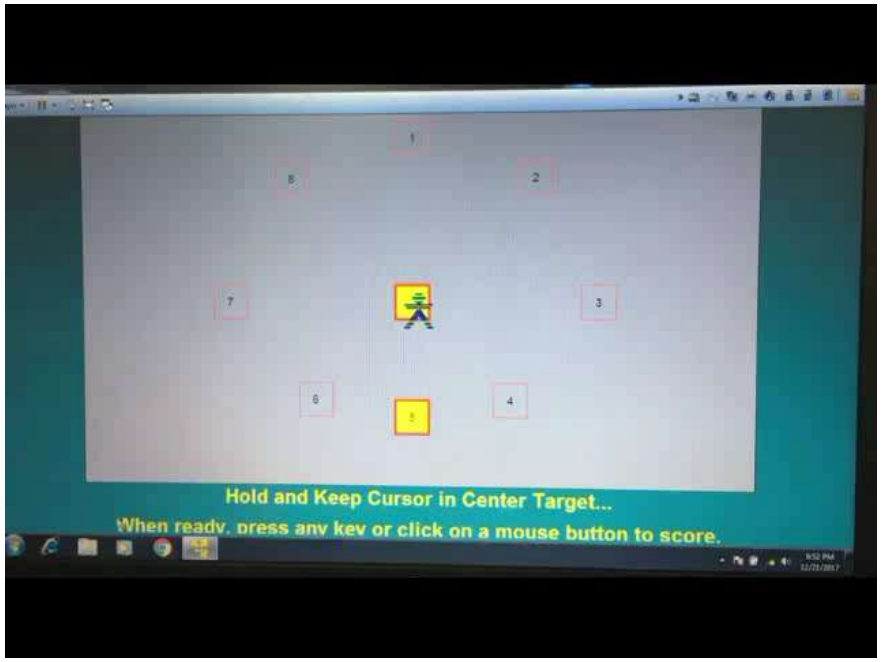


Limits of Stability



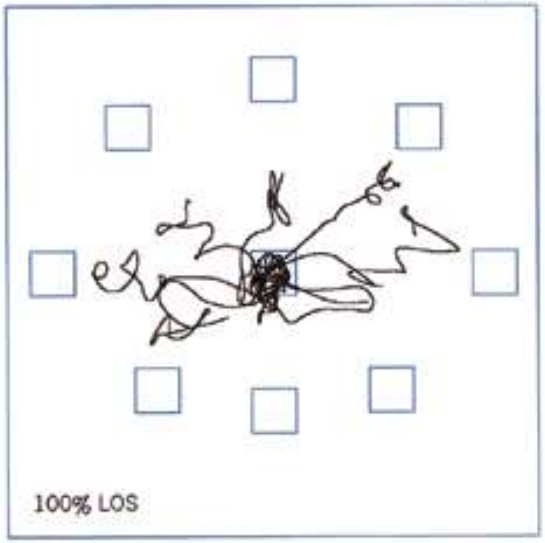


Limits of Stability

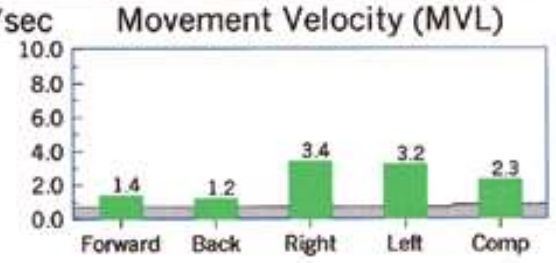


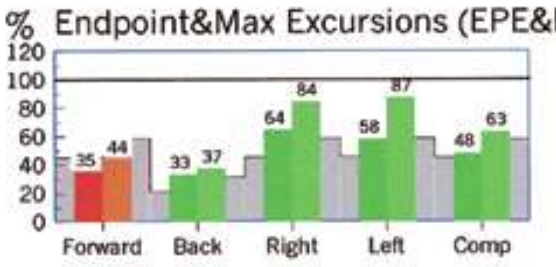
LOS - Results

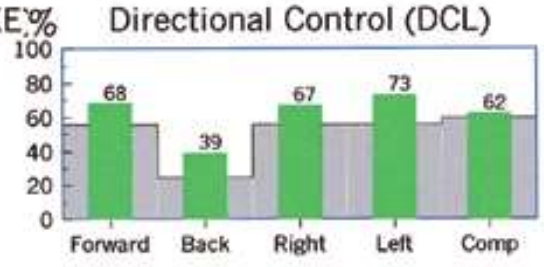
Limits Of Stability



Transition	RT (sec)	MVL (deg/sec	EPE (%)	MXE (%)	DCL (%)
1 (F)	0.26	1.3	43	52	63
2 (RF)	1.19	2.9	62	79	86
3 (R)	1.04	3.5	49	84	65
4 (RB)	0.52	2.4	58	58	53
5 (B)	0.25	1.3	37	37	23
6 (LB)	0.72	2.3	62	83	57
7 (L)	0.54	2.8	53	82	87
8 (LF)	0.50	2.9	32	55	61

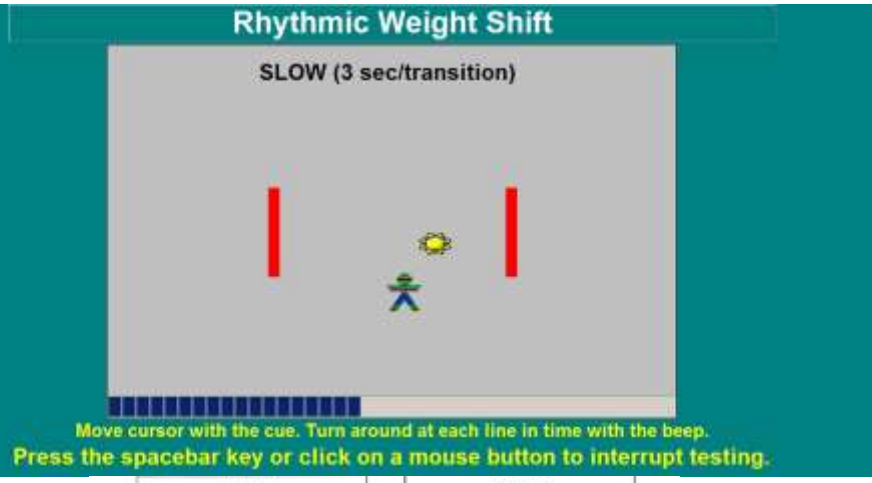


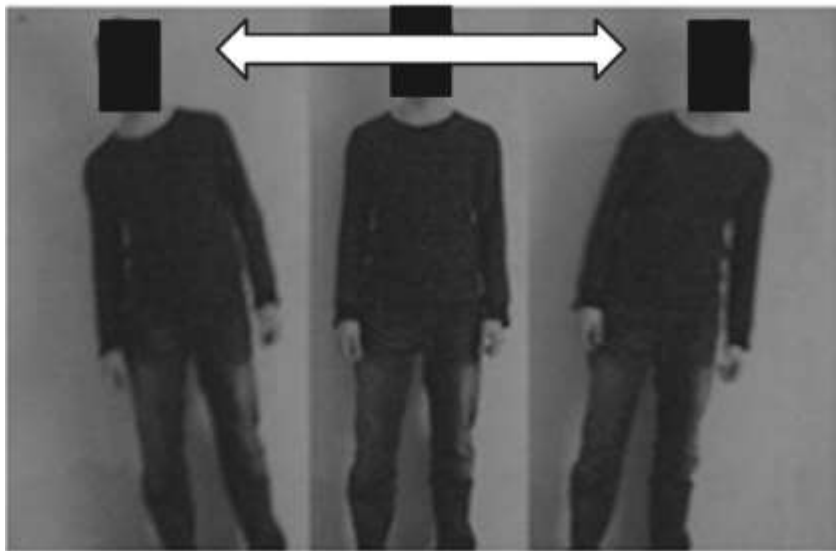


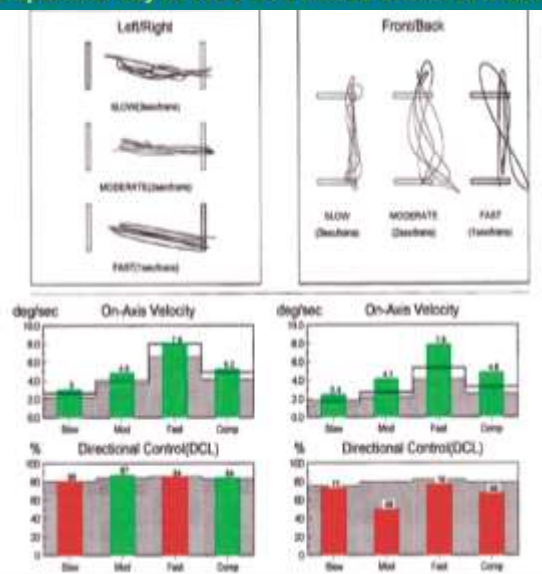


Rhythmic Weight Shift

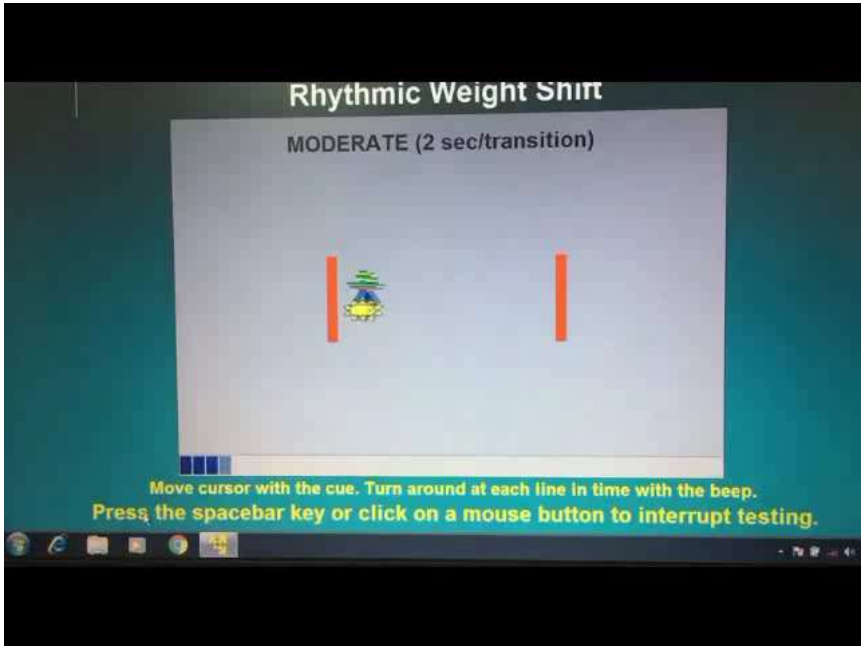
- Ability to move COG between 2 targets



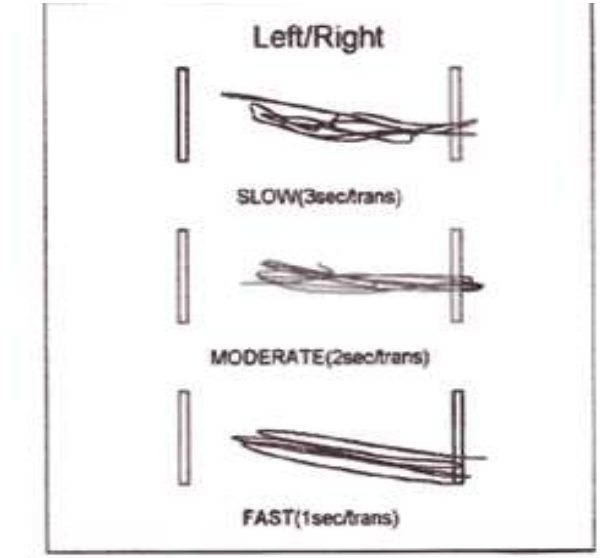


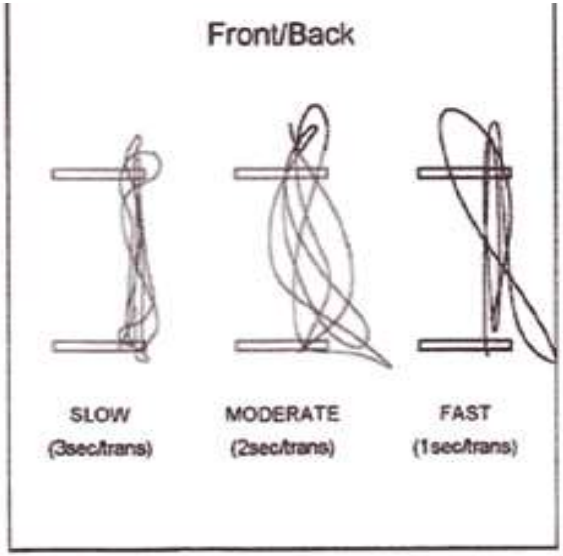


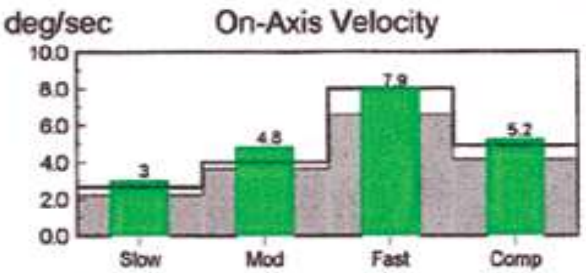
Rhythmic Weight Shift

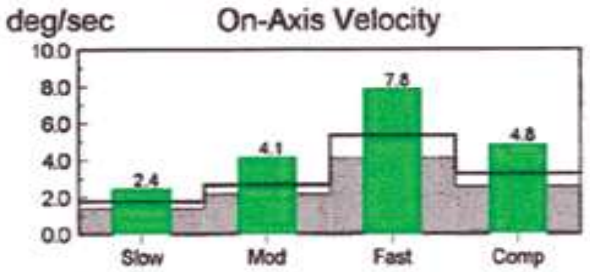


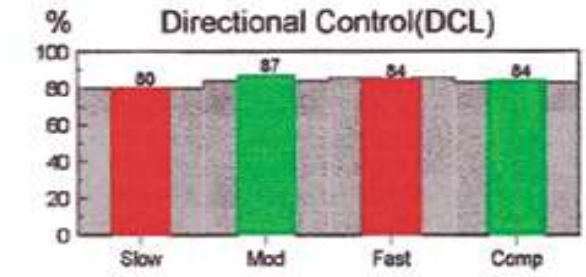
Rhythmic Weight Shift

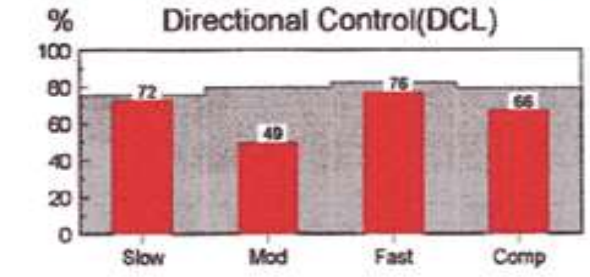












Unilateral Stance

DYNAMIC POSTUROGRAPHY

DEFINITION: AAOHNS & AAN

- Isolation and quantification of **orientation inputs** from visual, vestibular and somatosensory systems.
- Isolation and quantification of **central integrating mechanisms** for selecting functionally appropriate orientation sense(s).
- Isolation and quantification of **functionally appropriate movement strategy(s).**
- Isolation and quantification of **motor output mechanisms** for generating timely and effective postural movements.

Dynamic Posturography

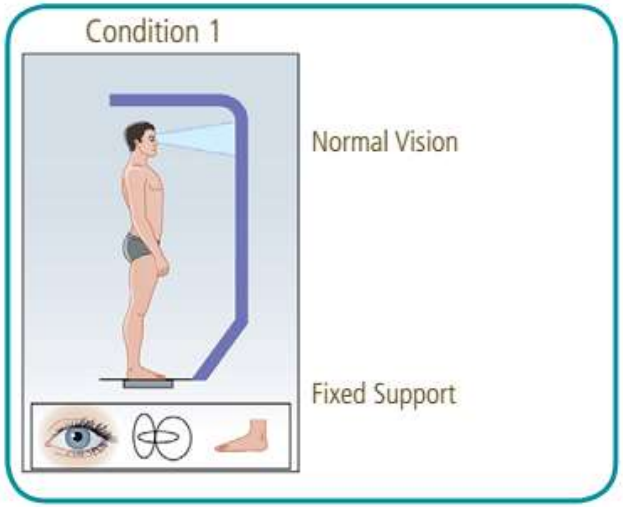
- **Sensory Organisation Test**
- **Limits of Stability**
- **Adaptation Test**
- **Motor Co-ordination Test**

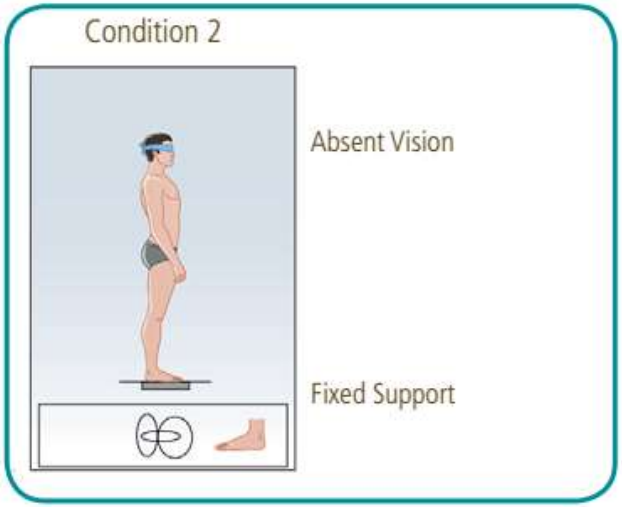
Sensory Organization Test

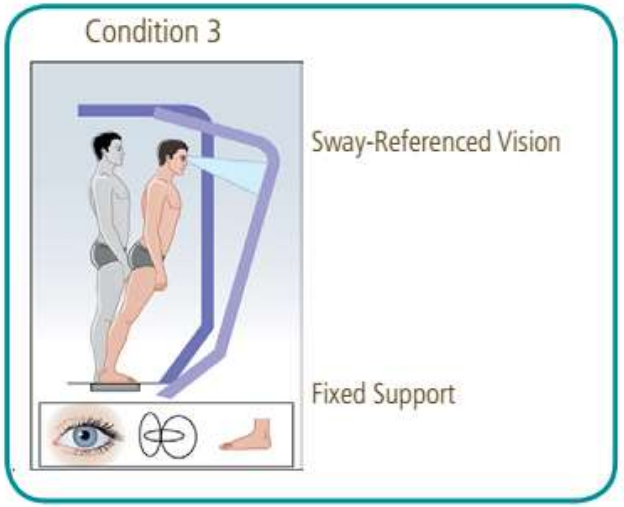
- Objectively identifies the abnormalities in use of sensory systems
- Assessed in 6 test conditions

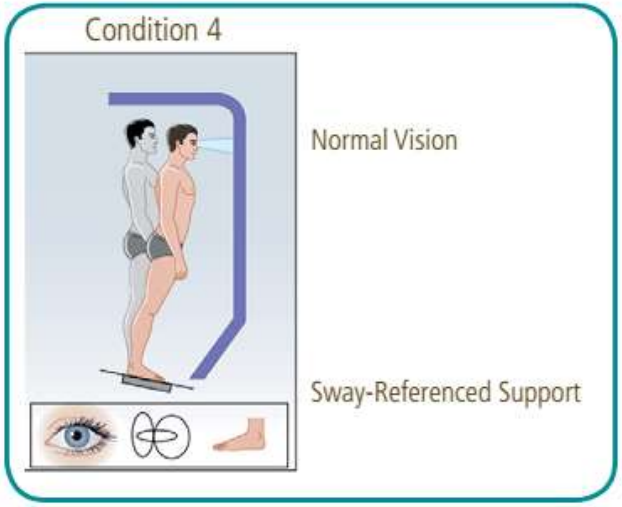
Condition	Vision	Surface	Visual surrounding
1	Eyes open	Stable	Stable
2	Eyes closed	Stable	Stable
3	Eyes open	Stable	Sway Referenced
4	Eyes open	Sway Referenced	Stable
5	Eyes closed	Sway Referenced	Stable
6	Eyes open	Sway Referenced	Sway Referenced

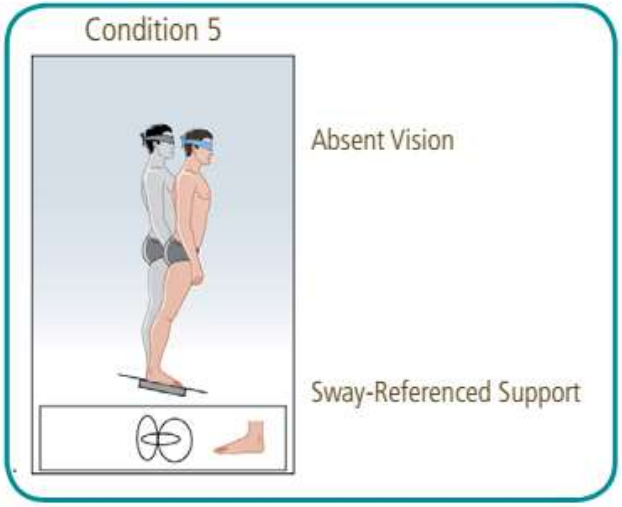
Sensory Organization Test

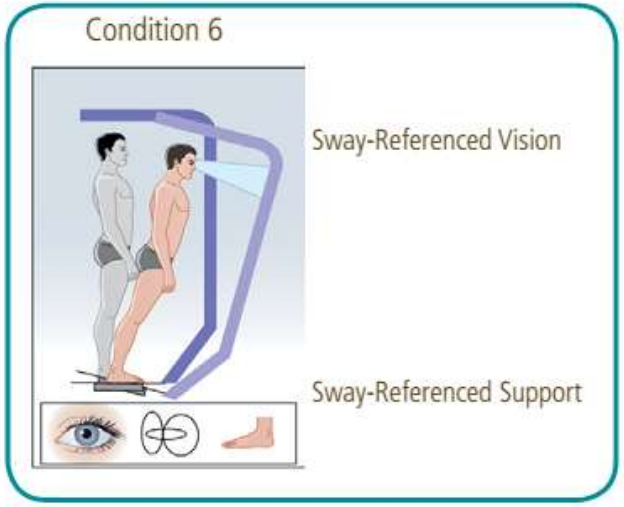




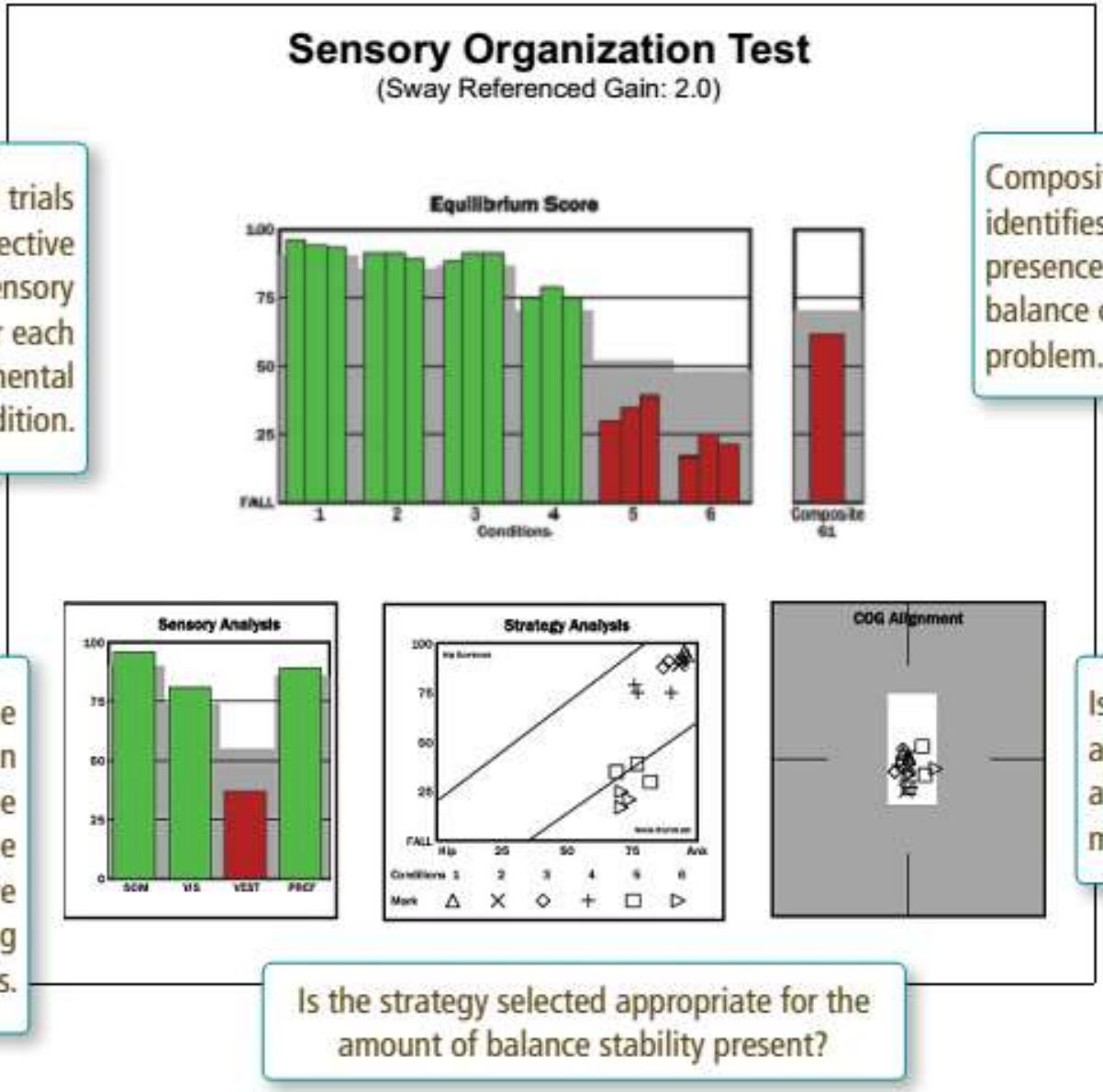








SOT - Results



Individual trials isolate the effective use of each sensory system under each environmental condition.

Composite score identifies the presence of a balance control problem.

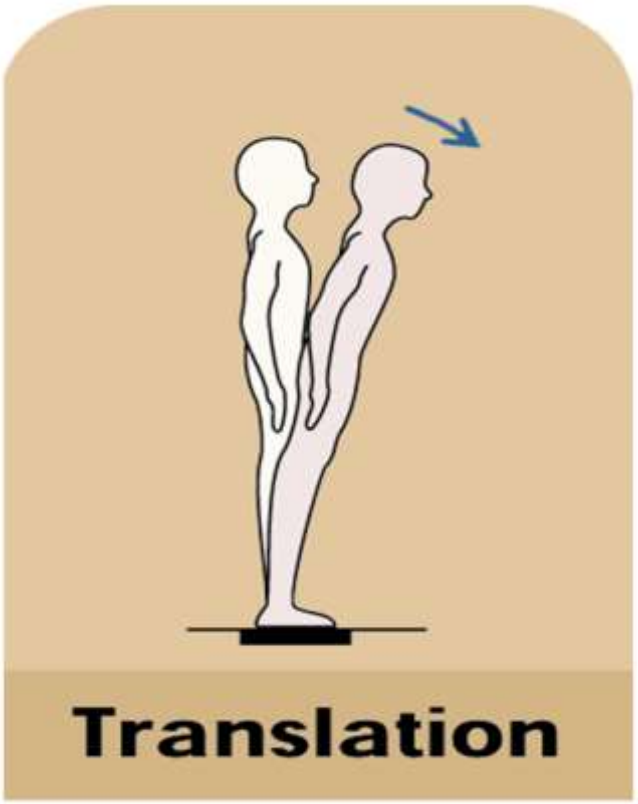
Summarizes the overall function of the three systems and the ability to resolve conflicting sensory inputs.

Is the patient appropriately aligned to midline?

Is the strategy selected appropriate for the amount of balance stability present?

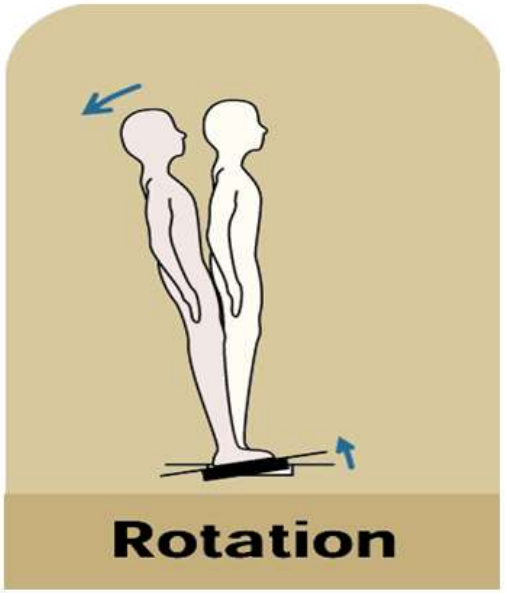
Motor Control Test

- Assesses the ability of motor system to counter the small unexpected external disturbance.



Adaptation test

- Assesses patient's ability to modify motor reactions and minimize sway when the support moves unpredictably in the Toes up/down direction.
- Simulates daily life conditions (uneven surface)
- Slow toes up/down rotations
- 8 deg/s



Applications

- Objective assessment of balance
- Preference of system used for balance
- Identification of neurological disorders
- Rehabilitation programme
- Non-organic Postural instability
- Monitoring recovery
- Documentation
- Specificity of over 90%*

*Di Fabio RP **Meta-analysis of the sensitivity and specificity of platform posturography.** Arch Otolaryngol Head Neck Surg. 1996 Feb;122(2):150-6

DEPARTMENTAL STUDIES IN RELATION TO POSTUROGRAPHY

ASSESMENT OF BALANCE BY POSTUROGRAPHY – A COMPARATIVE STUDY IN PRE AND POST OPERATIVE PATIENTS UNDERGOING CANAL WALL UP AND CANAL WALL DOWN MASTOIDECTOMY

Scheme of study

- Patient presents to ENT OPD
- Diagnosed as a case of COM squamous based on history and clinical examination
- Pre op static posturography
- Undergoes CWU/CWD procedures
- Computerised static posturography done at end of 1st,3rd and 6th month post op

Pre-operative MSW

GROUP	N	MEAN SWAY VELOCITY		P-value
		Mean	SD	
CWU	25	2.076	0.1631	0.0056
CWD	25	2.188	0.1032	

Pre & Post operative MSW

GRP	Pre op MSW	Post op Mean Sway Velocity					
		1 Month		3 Month		6 Month	
	Mean	Mean	SD	Mean	SD	Mean	SD
CWU	2.076	2.54	0.18	2.21	0.13	2.10	0.13
CWD	2.188	2.67	0.15	2.38	0.10	2.23	0.10
P-value	0.056	0.013		0.0001		0.0004	

Conclusions

- Pre-operative occult vestibular dysfunction in COM patients undergoing CWU/CWD mastoidectomy.
- More vestibular dysfunction in COM patients undergoing CWD surgery both pre & post operatively.
- The vestibular function gets compensated in course of 06 months.

A STUDY TO COMPARE POST OPERATIVE VESTIBULAR DEFICIT IN PATIENTS OF OTOSCLEROSIS HAVING UNDERGONE SMALL FENESTRA STAPEDOTOMY BY CONVENTIONAL AND LASER ASSISTED TECHNIQUE.

Scheme of study

- Patient presents to ENT OPD with complaint of hearing loss
- Clinical evaluation, Audiometry, Tympanometry, HRCT temporal bone
- Pre op static posturography
- Undergoes Stapedotomy
- Computerised static posturography done at end of 1st and 4th week post op

Group 1: Conventional

	Baseline	1st week	4th week
Mean sway velocity (deg/s)	0.713	0.938	0.763
p value		0.000	0.003
VSS-sf-V score (0-32)	0.250	1.525	0.350
p value		0.000	0.102

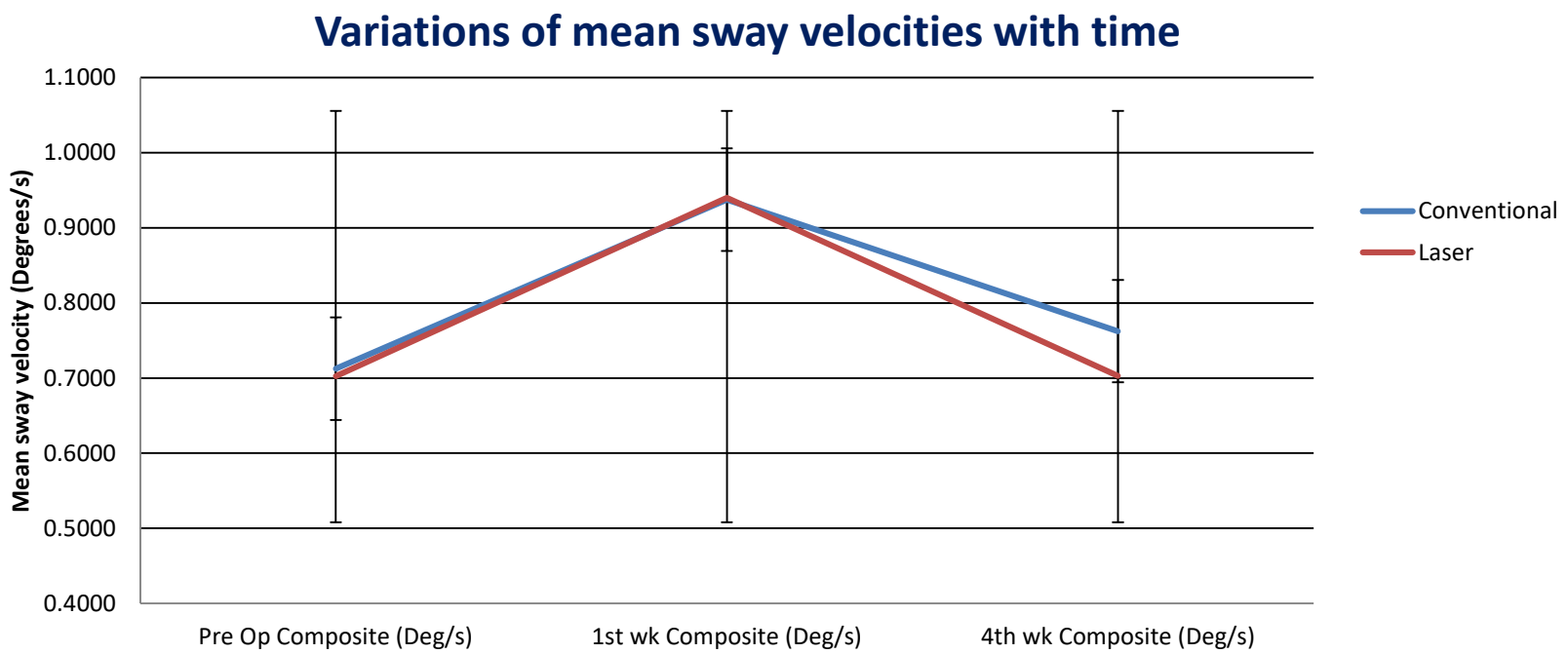
Comparison of pre and post op sway velocity and VSS-sf-V in Conventional group (Wilcoxon Signed Rank Test)

Group 2: Laser

	Baseline	1st week	4th week
Mean sway velocity (deg/s)	0.703	0.940	0.703
p value		0.000	0.798
VSS-sf-V score (0-32)	0.225	1.750	0.400
p value		0.000	0.106

Comparison of pre and post op sway velocity and VSS-sf-V in Laser group (Wilcoxon Signed Rank Test)

Conventional vs Laser



	Pre op	1st week	4th week
Conventional	0.7125	0.9375	0.7625
Laser	0.7025	0.9400	0.7030
p value	0.905	0.883	0.045

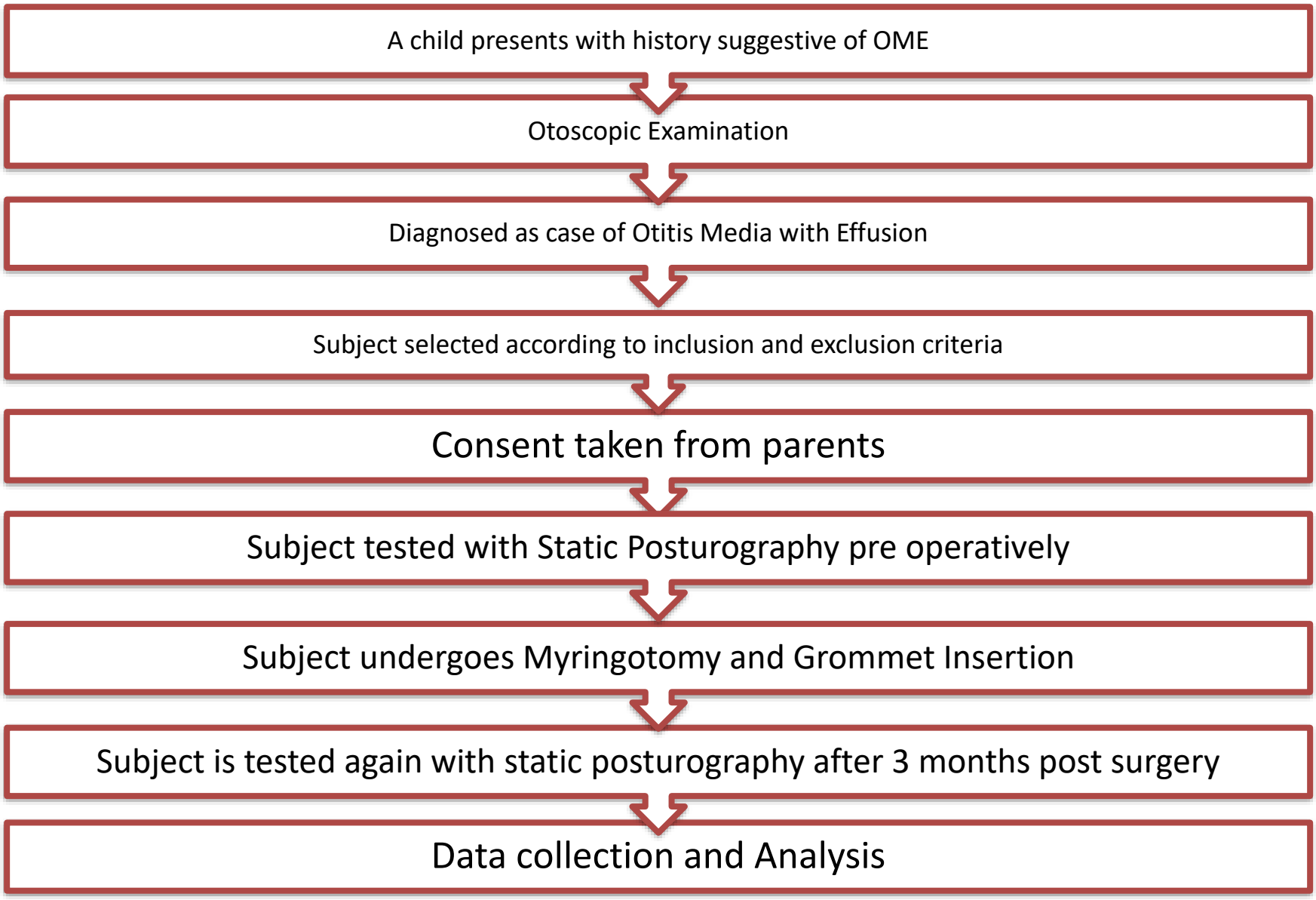
Comparison of mean sway velocity between two groups (Mann Whitney U test)

Conclusions

- Stapedotomy by conventional and CO2 Laser assisted technique results in vestibular dysfunction post-surgery.
- Vestibular dys recovers to pre-op levels by the end of 1st month after sx in pts undergoing CO2 Laser assisted stapedotomy while it remains higher than pre-op levels in pts undergoing conventional stapedotomy.
- The use of CO2 Laser- faster recovery of vestibular function.
- The use of CO2 Laser can hence be recommended in Stapedotomy.

A study to evaluate the effect of otitis media with effusion on vestibular system in children

Scheme of study



A STUDY TO EVALUATE VESTIBULAR FUNCTION USING STATIC POSTUROGRAPHY IN PATIENTS WITH CHRONIC OTITIS MEDIA (MUCOSAL) ACTIVE UNDERGOING CORTICAL MASTOIDECTOMY WITH OR WITHOUT OSSICULOPLASTY.

STUDY DESIGN

- An observational comparative analytical cohort
- 2 yrs
- To evaluate the effect of COM (mucosal) active on vestibular system by static posturography.
- Assess the change in vestibular function after cortical mastoidectomy with or without ossiculoplasty 3 months post op.

OTHER APPLICATIONS

Posturography in PD

- Detecting quantum of postural instability
- Identification of patients with a risk of recurrent falls in PD*
- Monitoring of any deterioration of posture control
- Monitoring response to exercise therapies specifically addressing balance dysfunction**

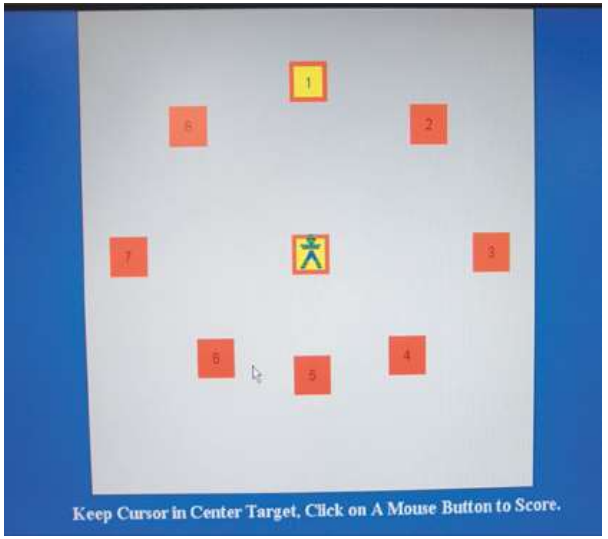
Johnson L[1], James I, Rodrigues J, Stell R, Thickbroom G, Mastaglia F. Clinical and posturographic correlates of falling in Parkinson's disease. Mov Disord. 2013 Aug;28(9):1250-6*

Klamroth S[1], Steib S, Devan S, Pfeifer K. Effects of Exercise Therapy on Postural Instability in Parkinson Disease: A Meta-analysis. J Neurol Phys Ther. 2016 Jan;40(1):3-14**

Progressive Supranuclear Palsy & PD

PSP pts:

- SOT Score- significantly worse
- Total LOS time and path sway - significantly prolonged
- Levodopa administration – no improvement



Computerised Posturographic Analysis of Progressive Supranuclear Palsy: A case-control comparison with PD and healthy controls. Ondo W et al. Arch Neurol. 2000;57:1464-1469.

Vestibular Disorders

- Diagnosis in conjunction with other tests.
- Detect balance problems in the elderly and start preventative balance training .*
- Assessment and monitoring of individualized vestibular rehabilitation therapy in peripheral vestibular disorders.**

* Kristinsdottir EK, Jarnlo G-B, Magnusson M: Asymmetric vestibular function in the elderly might be a significant contributor to hip fractures. Scand J Rehabil Med 2000, 32:56–60.

**Black FO, Angel CR, Pesznecker SC, et al.: Outcome analysis of individualized vestibular rehabilitation protocols. Am J Otol 2000, 21:543–551.

BPPV

- Management : CRM
- Some patients – residual postural instability
- Vestibular rehabilitation exercises using dynamic posturography
- Helpful adjunct to the treatment

Blatt PJ et al. **The effect of the canalith repositioning maneuver on resolving postural instability in patients with benign paroxysmal positional vertigo.** Am J Otol. 2000 May;21(3):356-63.

Zhang DG et al. Clinical value of dynamic posturography in the evaluation and rehabilitation of vestibular function of patients with benign paroxysmal positional vertigo. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2010 Sep;45(9):732-6

Risk of falls in elderly

- 206 Patients
- < 65 yrs
- SOT
- Multi-fallers :

  - Visual input occlusion- more sway

  - Distorted visual and somatosensory inputs- recurrent falls with no postural adaptation.
- Posturography more sensitive than clinical balance tests (Timed 'Up & Go' test, One-Leg Balance, Sit-to-Stand-test).

Buatois S. Posturography and risk of recurrent falls in healthy non-institutionalized persons aged over 65. Gerontology. 2006;52(6):345-52

STROKE

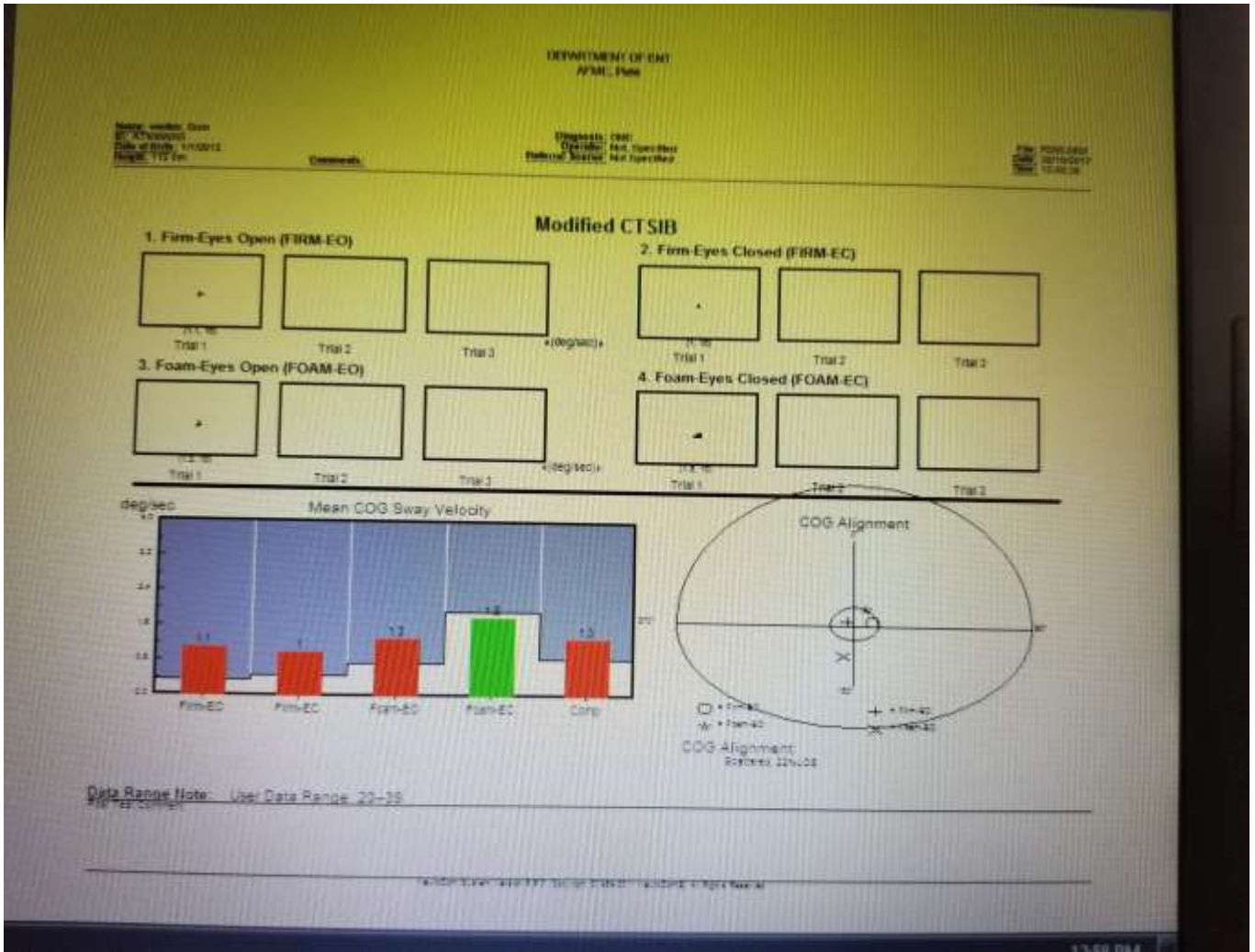
- Reestablishment of balance function.
- Biofeedback to patients regarding the locus of their center of force (COF) or center of pressure (COP), as well as training protocols to enhance stance symmetry, steadiness, and dynamic stability.
- CDP training program - a systematic, objective method to reduce fall risk with improved overground performance of balance tasks in an individual with chronic stroke.

Nichols DS[1]. **Balance retraining after stroke using force platform biofeedback.** Phys Ther. 1997 May;77(5):553-8.

Non organic imbalance

- Substandard performance on sensory tests 1 & 2.
- Better performance on a more difficult test (ST 5 & 6): this was determined using the formulae
  Score = [(Score1 − Norm1) + (Score2 − Norm2)] − [(Score5 − Norm5) + (Score6 − Norm6)].
- Regular periodicity of sway
- Large amplitude AP sway that exceed 5° without falls on ST 4, 5, and 6
- Large amplitude lateral sway that exceed 1.25° without falls on ST 4, 5, and 6
- Excessive inter-trial variability
- Inconsistent motor responses to small and large translational perturbations

Non organic imbalance mCTSIB - Results



Psychogenic imbalance

- Regular periodicity of sway
- Circular sway
- Inconsistent motor Response

Herdman SJ et al. Misclassification of Patients with Spinocerebellar Ataxia as Having Psychogenic Postural Instability Based on Computerized Dynamic Posturography. Front Neurol. 2011; 2: 21.

SPACEFLIGHTS

- Recovery of CDP to baseline as a criterion

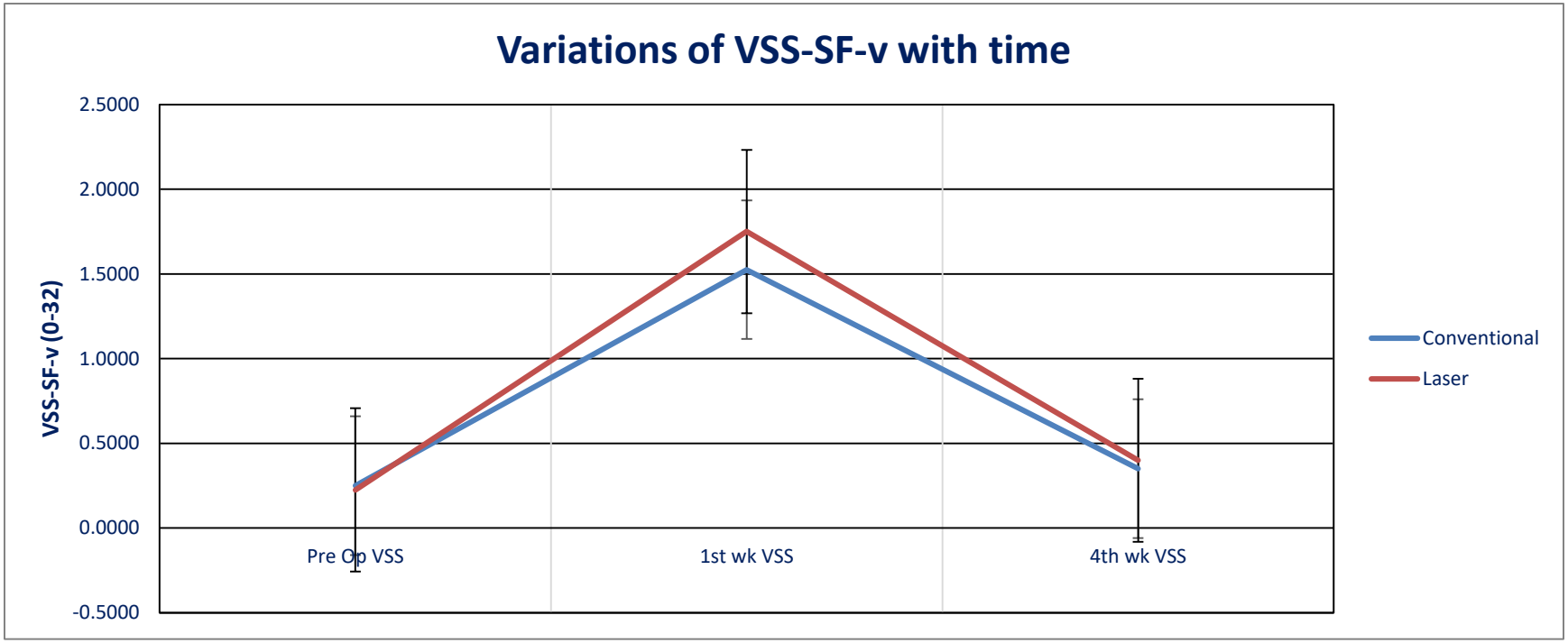
  for return to duty after long-duration (space station) spaceflights.

Limitations

- Test of postural control as a whole
- Lack of topographic specificity
- Sensitivity of 61% to 89%

THANK YOU

Conventional vs Laser



	Pre op	1st week	4th week
Conventional	0.2500	1.5250	0.3500
Laser	0.2250	1.7500	0.400
p value	0.642	0.704	0.871

Comparison of VSS-sf-V between two groups (Mann Whitney U test)