Balance Assessment and Rehabilitation in Audiology

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ABMU Health Board
Balance Mechanism

- This has 3 components
  - Sensory Input
  - Central Processing
  - Motor Output
Peripheral Component

- Peripheral sensory apparatus
  - Motion sensors send info to CNS
  - Visual/vestibular/proprioceptive

- Send info to vestibular nucleus and cerebellum about head angular velocity, linear acceleration and head orientation
Figure 17.23a, b, & d
Figure 17.23c

Diagram showing the direction of duct rotation and the relative endolymph movement in the semicircular duct. The ampulla is also indicated at rest.
Figure 17.24

- Vestibular ganglion
- Vestibular branch
- Vestibule
- Semicircular canals
- Vestibulocochlear nerve (VIII)
- Red nucleus
- Vestibular nucleus
- To superior colliculus and relay to cerebral cortex
- To cerebellum
- Vestibulospinal tracts
CNS Component

- CNS processes visual, proprioceptive, auditory, vestibular and tactile inputs together with cognitive knowledge about an impending movement.

- This allows vestibular responses to be based on a richly textured, multi-modal sensory array.
Motor Output Component

- Output of central vestibular system goes to the ocular muscles to serve the Vestibular Ocular Reflex and to the spinal cord to serve the vestibular spinal reflex
- The VOR generates eye movements to enable clear vision whilst head in motion
- The VSR generates compensatory body movements to maintain head and postural stability, preventing falls
- The VOR and VSR are monitored by the CNS and adjusted by adaptive processor
Classification of Balance Disorder

- Vertigo
  - a hallucination of movement either of the patient or their surroundings.

- Dizziness
  - vaguer definition such as light-headedness, unsteadiness or faintness
Incidence of Balance Disorder

- 42% population have suffered at some time
- 10/1000 consult GP each year due to imbalance
- Prevalence increases with age from 20% in 18 to 50 yr olds to 60% by 75 yrs
- Demand for vestibular rehabilitation through conventional referral mechanisms around 1/1000 of population per year
Effects of Balance Disorder In the Elderly

- 17% of falls in elderly due to balance disorder (Exton-Smith 1977)
- In the US, around 30% of those over 65 yrs have a fall with half having multiple events
- 10 to 15% of falls result in serious injuries
- Unintentional injury is sixth leading cause of death, with majority of unintentional injury deaths from falls, especially in over 85yrs group
Causes of Peripheral Vertigo

- Ear
  - otitis media
  - mastoid infection
  - cholesteatoma
  - trauma
  - foreign body/impacted wax
- Menieres syndrome
- BPPV
Causes of Peripheral Vertigo

- Vestibular neuronitis
- Ototoxic drugs
- Otosclerosis
- Motion sickness
- Psychogenic
Causes of Central Vertigo

- Vertebrobasilar Insufficiency
- Stroke (cerebellar)
- Acoustic Neuroma
- Tumours
- Degenerative CNS disease (eg MS)
- Head Trauma
- Psychogenic
- Epilepsy
- Migraine
Causes of Dizziness

- Arterial e.g. Hypertension
- Cardiac e.g. mechanical obstruction
- Metabolic e.g. Hypoglycaemia, Hyperventilate
- Drugs
- Psychogenic
- Ocular
- Systemic Disease
- Migraine
- Proprioceptive Disorder-Peripheral neuropathy e.g. Vit deficiency, alcohol, diabetes, anaemia
### Key Items in History

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Tempo</th>
<th>Symptoms</th>
<th>Circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestibular</td>
<td>Acute dizziness</td>
<td>Vertigo, dysequilibrium, N/V, oscillopsia</td>
<td>Spontaneous, exacerbated by head move</td>
</tr>
<tr>
<td>Neuritis</td>
<td>&lt;=3 days</td>
<td>dysequilibrium, N/V, oscillopsia</td>
<td></td>
</tr>
<tr>
<td>BVL or &gt;3 days</td>
<td>Chronic dizziness</td>
<td>Dizzy, dysequilibrium, occasional</td>
<td>Induced by head moves, walking. Worse in dark/uneven surface</td>
</tr>
<tr>
<td>from UVL</td>
<td>&gt; 3 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BPPV</td>
<td>Spells:Secs</td>
<td>Vertigo, lightheaded, nausea</td>
<td>Positional: lying down, sitting up/turning in bed, bending</td>
</tr>
</tbody>
</table>
### Key Items in History

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<th>Disorder</th>
<th>Tempo</th>
<th>Symptoms</th>
<th>Circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthostatic</td>
<td>Spells :secs</td>
<td>Lightheaded</td>
<td>Positional: standing up</td>
</tr>
<tr>
<td>hypotension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIAs</td>
<td>Spells:mins</td>
<td>Vertigo, lightheaded, dysequilibrium</td>
<td>spontaneous</td>
</tr>
<tr>
<td>Migraine</td>
<td>Spells:mins</td>
<td>Vertigo, dizziness, motion sick</td>
<td>Usually movement induced</td>
</tr>
<tr>
<td>Menieres</td>
<td>Spells:Hrs</td>
<td>vertigo, dysequilibrium, ear full, hearing loss, tinnitus</td>
<td>Spontaneous exacerbated by head movement</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Mechanism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysequilibrium: Imbalance</td>
<td>Loss of vestibulospinal, proprioceptive, visual or motor function. Psychological</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightheadedness: Presyncope</td>
<td>Decreased blood flow to brain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mal de Debarquement</td>
<td>Maladaptation of earth unstable environment Anxious patients predisposed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motion Sickness</td>
<td>Visual-vestibular mismatch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea &amp; Vomiting</td>
<td>Stimulation of dorsal medulla</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Symptoms of Dizziness

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillopsia: Illusion of visual motion</td>
<td>Spontaneous: Acquired nystagmus</td>
</tr>
<tr>
<td>Psychological: Floating, swimming, spinning</td>
<td>Anxiety, depression, somatiform disorders</td>
</tr>
<tr>
<td>inside of head</td>
<td></td>
</tr>
<tr>
<td>Vertical diplopia</td>
<td>skew eye deviation</td>
</tr>
<tr>
<td>Vertigo: Rotation, linear movement, tilt</td>
<td>Imbalance of tonic neural activity to vestibular cerebral cortex</td>
</tr>
<tr>
<td>Routine Physical Exam</td>
<td>Pathology</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Physical Exam</strong></td>
<td></td>
</tr>
<tr>
<td>Spontaneous Nystagmus</td>
<td>Acute UVL or brainstem/cerebellum abnormality</td>
</tr>
<tr>
<td>present</td>
<td></td>
</tr>
<tr>
<td>Skew eye deviation</td>
<td>Otolith abnormality</td>
</tr>
<tr>
<td>(Ocular tilt reflex)</td>
<td></td>
</tr>
<tr>
<td>Decreased VOR</td>
<td>Acute UVL and chronic vestibular hypofunction</td>
</tr>
<tr>
<td>Eye Movements and</td>
<td>Usually BPPV, rarely central</td>
</tr>
<tr>
<td>vertigo elicited by</td>
<td>BPPV, hypermobile stapes</td>
</tr>
<tr>
<td>manouever</td>
<td></td>
</tr>
<tr>
<td>Visual tracking</td>
<td>Brainstem/cerebellar abnor</td>
</tr>
<tr>
<td>impaired</td>
<td></td>
</tr>
<tr>
<td>Imbalance while</td>
<td>Any of the above</td>
</tr>
<tr>
<td>standing</td>
<td></td>
</tr>
</tbody>
</table>
# Spontaneous Nystagmus

Features to distinguish peripheral from central

<table>
<thead>
<tr>
<th>Findings</th>
<th>Peripheral</th>
<th>Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause</td>
<td>Nystagmus decreases</td>
<td>Nystagmus either doesn’t</td>
</tr>
<tr>
<td></td>
<td>Fixation</td>
<td>change or decreases</td>
</tr>
<tr>
<td>Effect of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixation</td>
<td>Nystagmus decreases</td>
<td>Nystagmus either doesn’t</td>
</tr>
<tr>
<td>Direction of</td>
<td>Usually mixed plane</td>
<td>change or decreases</td>
</tr>
<tr>
<td>Nystagmus</td>
<td>horizontal and torsional</td>
<td></td>
</tr>
<tr>
<td>Effect of Gaze</td>
<td>Nystagmus increases</td>
<td>Nystagmus either doesn’t</td>
</tr>
<tr>
<td></td>
<td>with gaze towards</td>
<td>change or it reverses</td>
</tr>
<tr>
<td></td>
<td>direction of quick</td>
<td>direction</td>
</tr>
<tr>
<td></td>
<td>phase</td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>Procedure</td>
<td>Result</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>Head Thrust</td>
<td>Thrust the head as patient fixates a target</td>
<td>Refixation saccade indicates vestibular defect</td>
</tr>
</tbody>
</table>
## Bedside Tests of the VOR

<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Shaking</td>
<td>Oscillate the head 20 times</td>
<td>Nystagmus suggests vestibular imbalance</td>
</tr>
<tr>
<td>Nystagmus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Bedside Tests of the VOR

<table>
<thead>
<tr>
<th>Test</th>
<th>Procedure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestibular</td>
<td>The patient reads the lowest visible line on a snellen chart during 2 Hz head oscillation</td>
<td>Vestibular defect if they can only read lines higher than 3 above static visual activity</td>
</tr>
<tr>
<td>dynamic visual activity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Station and Gait

- Romberg : No Fall
- Sharpened Romberg (tandem stance) : Falls with eyes closed
- Fukuda/Unterberger Stepping Test : Rotates > 30 degrees
- Modified CTSIB
- Gait : Slow and cautious. While turning, there is no independent head-on-body movements
Elements Of Balance Intervention in Audiology

- Referral mechanism
- Assessment
  - diagnosis of causes of disorder
- Counselling
  - information sharing with patient
  - behavioural/cognitive therapy
- Intervention regimes
  - regime/time scale agreed with patient
- Outcome Measures
  - questionnaires/posturography
Patient Triaged

Appointment in Balance Clinic
Conversation with Patient
- history/questionnaire/posturography

Balance Tests

Discussion with patient
- decision re treatment/further tests/onward referral

Follow up appointment
- questionnaire/posturography

Discharge From Audiology/Referral back to ENT/Neurology/Tertiary Centre/Psychology/Open Return to clinic

Primary Care - Management of Most Cases
- integrated falls service

Patient Requires Medical/Surgical Management

Balance Exercises

Further Tests/Imaging
Assessment of Balance Disorder

- Clinical History
- Questionnaire Measures
  - Vestibular Rehab Benefit Questionnaire
- Hearing tests/tympanometry/Otoscopy
- Direct Observation of eye movement
- Office Tests
Assessment of Balance Disorder

- Positional Testing
- VNG/ENG recording of eye movement
- Posturography
- Electrophysiological Recording of Occular Vestibulo-Evoked Myogenic Potentials
- Imaging
- Other medical tests-bloods etc
- Assessment by Clinical Psychology
Benign Paroxysmal Positional Vertigo

- Incidence is 11 to 64 per 100,000
- Experienced by 17% of dizzy clinic patients
- Causes
  - 49% Idiopathic
  - 18% Trauma
  - 18% Menieres/VBI/Migraine/MS
  - 15% Viral
Comparative Efficacy Of Treatments for BPPV

<table>
<thead>
<tr>
<th>Protocol</th>
<th>No. Subjects</th>
<th>% Improved</th>
<th>Treatment /Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandt/Daroff</td>
<td>67</td>
<td>98</td>
<td>up to 14 days</td>
</tr>
<tr>
<td>Semont manouevre</td>
<td>711</td>
<td>84</td>
<td>1</td>
</tr>
<tr>
<td>Epley</td>
<td>30</td>
<td>100</td>
<td>several manouevres</td>
</tr>
<tr>
<td>Herdman et al manouevre</td>
<td>30</td>
<td>90</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(modified Epley)</td>
</tr>
</tbody>
</table>
Guidelines to BPPV Treatment

- Anxious patients
  - modified Brandts - floor not bed
  - single treatment - Semont/Epley

- Patients unable to stay upright for 48 hours
  - Brandts

- Poor Compliance on Brandts
  - Semont/Epley

- Disturbing Nausea/Vomiting
  - medication e.g., Phenergan 1/2 hr before
Guidelines to BPPV Treatment

- Cervical/back pain precludes Semont/Epley
  - modified Brandts
- Slight possibility of neck injury in Semont/Epley
  - ensure head/neck always supported
- Bilateral BPPV-Semont/Epley not used
  - each side treated separately
Furman, JM & Cass, SP, 1999
Intervention Regimes

- Habituation Therapy eg Cawthorne-Cooksey
  - physical exercises promote central compensation for unilateral vestibular deficit
  - relies on plasticity in CNS to recalibrate gain of vestibulo-ocular reflex

- Balance Retraining
  - rehabilitation for central processing disorders, bilateral vestibular loss, proprioceptive abnormalities
  - use redundancy in balance system to promote alternative balance strategies
Intervention Regimes

- Psychological Therapy (Behavioural and Cognitive)
  - Imbalance may also arise from or be complicated by psychological sequelae such as high anxiety states
  - must be taken into account in strategy

- Breathing Exercises
  - Hyperventilation can occur independently or in conjunction
Contraindications for Habituation Exercises

- Vertebrobasilar Insufficiency
- Fistula
- Severe Cardiac Disease
- Severe Musculo-Skeletal Disease
Efficacy Of Intervention

- Province et al (1995) FICSIT Meta-Analysis
  - balance training significantly reduced falls in the elderly \( (p < 0.01) \)

- Keim et al (1992)
  - complete symptom resolution in 64%
  - partial resolution in another 28%

  - symptom resolution in 85%

- Shepard et al (1990)
  - symptom reduction in 87%
  - reduction in disability in 83%
Benefits of Intervention

- Patient
  - reduction in chance of falls
  - reduction in disability and handicap
  - improved independence/self confidence
  - improved quality of life

- Patients family and friends
  - reduction in financial/moral support
  - improved quality of life

- GP
  - reduction in consultations/referrals
  - reduction in prescriptions
Benefits of Intervention

- Hospital Specialists
  - reduction in follow-up consultations
  - more time for other patients

- Hospital Trust
  - more ‘new’ patients seen
  - patient receives effective treatment
  - reduction in outpatient waits

- Societal
  - financial benefit of patient returning to work
  - financial benefit in reduction of cost of care
Conclusions

- Audiology provides assessment of balance disorder and appropriate intervention
- Need for Better Integration of Audiology with Falls Services