1. Ocular Motor Evaluation

A. Smooth Pursuit (H-test)
Method: Hold the patient’s head stationary. Ask the patient to follow a slowly moving (20 deg/sec) object (finger, pen light) in an H pattern.

Normal response:

Abnormal response:

Clinical significance:

B. Saccades
Method: Hold the patient’s head stationary. Hold a pen and your finger approximately 8-10 inches apart 10-12 inches in front of the patient. Ask the patient to look at your finger and then the pen, varying the amount of time between commands.

Normal response:

Abnormal response:

Clinical significance:

C. Skew Deviation (Cover/Uncover test)
Method: Cover one eye with your hand. As you uncover the eye observe for any movement of the uncovered eye.

Normal response:

Abnormal response: Vestibular CNS

Clinical significance: Vestibular CNS
**D. Convergence/Divergence:**
Method: Have patient focus on your finger or an object and maintain focus as you bring the object towards the patient’s nose. Ask patient to tell you when they see double. Observe for nonconjugate eye movement, asymmetric papillary constriction or spasm of the eye.

Normal response:

Abnormal response:

Clinical Significance:

**E. VOR Cancellation**
Preparation: Clear the cervical spine.
Method: Grasp the patient’s head firmly with both hands on the side of their head; head tilted forward 30 degrees. Instruct the patient to keep their eyes on your nose. Slowly move the head from side to side while you move in the same direction/speed. OR have the patient hold his/her thumb out in front of the face at eye level and rotate the thumb/head/eyes at the same speed and in the same direction.

Normal test:

Abnormal test:

Clinical significance:

**F. Optokinetic Nystagmus**
Method: Ask patient to look at moving stripes, either light box, or have therapist move tape measure or striped material. Ask patient to look at stripes as they pass. Asking the patient to count the stripes sometimes makes patients understand the task better.

Normal test:

Abnormal test:

Clinical Significance:
2. Vestibular Eye-Head Coordination Evaluation

G. Spontaneous nystagmus
Method: Holding the patient’s head with one hand, have the patient look straight ahead and observe for nystagmus. (Repeat with gaze fixation removed (Frenzel lenses, etc))

Normal test:

Abnormal test:

Clinical significance:

H. Vestibular Ocular Reflex (x1 viewing)
Preparation: Clear the cervical spine.
Method: Grasp the patient’s head firmly with both hands on the side of their head; head tilted forward 30 degrees. Instruct the patient to keep their eyes on your nose. Move the head from side to side. Begin with slow head movements and gradually increase speed as patient is able to tolerate movement. The goal is to move at speeds greater than 2 Hz.

Normal test:

Abnormal test:

Clinical significance:

I. Head Thrust Test
Preparation: Clear the cervical spine. Inform the patient that you will be quickly moving their head a small distance. Instruct the patient to keep their eyes focused on your nose.
Method: Grasp the patient’s head firmly with both hands on the side of their head; head tilted forward 30 degrees. Move the patient’s head slowly back and forth being sure the patient is relaxed. Then, suddenly move the patient’s head from one side past midline and stop. This is a small amplitude movement. Repeat in the other direction, in a random or unpredictable fashion.

Normal test:

Abnormal test:

Clinical significance:
J. Head Shaking Nystagmus
Preparation: Clear cervical spine. Remove gaze fixation (Frenzel lenses, Ganzfeld).
Method: Tilt the patient’s head forward 30 degrees and grasp the head firmly with both hands on the side of their head. Have the patient close their eyes. Quickly move their head side to side (yaw plane) 20 times in a small amplitude movement. Quickly have them open their eyes.

Normal test:

Abnormal test:

Clinical significance:

K. Snellen Dynamic Visual Acuity (DVA) test (Illegible E test)
Preparation: Clear the cervical spine. Position the patient 20 feet from the EDTRS chart (or the appropriate chart distance).
Method:
1. Determine the static visual acuity by asking the patient to read to the lowest line that they can until they can not correctly identify all the letters on a given line. Record that Snellen ratio or LogMar value.
2. Determine the dynamic visual acuity. Stand behind the patient, grasp the patient’s head gently but firmly with both hands on the side of their head, tilted 30 degrees forward. While moving their head side to side at a frequency of 2Hz (2 cycles per second), have the patient read to the lowest line that they can until they can not correctly identify all the letters on a given line. This is a small amplitude movement. Record that Snellen ration or LogMar value. Note any symptoms.
3. Calculate the difference between the static and dynamic visual acuity.

Normal test:

Abnormal test:

Clinical significance:

Why is it important to maintain a minimum of 2 Hz speed?

Why is it important not to pause at the turns?

L. What do you need to evaluate before performing vestibular eye-head coordination tests?
3. Positional Testing

M. Motion Sensitivity Quotient

Clear Cervical and Lumbar spine.

Method: Have the patient move into each position. If the patient experiences an increase in symptoms have them rate the symptoms on a scale of 1 (mild) to 5 (severe). Time the duration of the symptoms and score on the scale of 0-4 seconds = 0; 5-10 seconds = 1; 11-30 seconds = 2; and > 30 seconds = 3. The duration and intensity values are added together for a score.

Scoring: The MSQ is calculated by multiplying the number of provoking positions by the score, dividing by 2048, and multiplying by 100 to give a percentage score.

Normal Test:

Abnormal Test:

Clinical Significance:

Motion Sensitivity Testing (Shepard et al 1990, 1993, 1995)

<table>
<thead>
<tr>
<th>Baseline Symptoms</th>
<th>Intensity (0-5)</th>
<th>Duration (0-3)</th>
<th>Score</th>
</tr>
</thead>
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<tr>
<td></td>
<td>0 = no symptoms</td>
<td>0 = 0-5 sec</td>
<td>Intensity + Duration</td>
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<tr>
<td></td>
<td>5 = maximal symptoms</td>
<td>1 = 5-10 sec</td>
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<td></td>
<td></td>
<td>2 = 11-30 sec</td>
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<td></td>
<td></td>
<td>3 = &gt;30 sec</td>
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</table>

1. Sitting to supine
2. Supine to left side
3. Supine to right side
4. Supine to sitting
5. Left Hallpike-Dix
6. Up from left
7. Right Hallpike-Dix
8. Up from right
9. Sitting, head tipped to left knee
10. Head up from left knee
11. Sitting, head tipped to right knee
12. Head up from right knee
13. Sitting head turns (5)
14. Sitting head pitches (5)
15. In stance, 180° turn to left
16. In stance, 180° turn to right

Total

MSQ = Total Score x (# of positions)/20.48 = ________________
N. Dix-Hallpike Position testing

Preparation: Clear the cervical and lumbar spine. Describe the procedure in detail to the patient in advance of testing. Instruct them to keep their eyes wide open and inform you of any symptoms.

Method: Have the patient long sit on a treatment table in a position which will allow their head to clear the end of the table when they lie down. Rotate their head 45 degrees to the right. Quickly lie them down, maintaining right head rotation while moving them to a position of 25-30 degrees of cervical extension. Maintain this position for at least 45 – 60 seconds noting reports of symptoms and the latency (time to onset) and duration of those symptoms. Repeat this on the left side.

Normal test:

Abnormal test:

Clinical significance:

The Dix-Hallpike Maneuver
O. Roll Test
Preparation: Clear the cervical and lumbar spine. Describe the procedure in detail to the patient in advance of testing. Instruct them to keep their eyes wide open and inform you of any symptoms.

Method: Have the patient lie supine on a treatment table with their head flexed 30°. Stand to the front and to the right of the patient, holding their head in both hands. Rotate their head 90 degrees to the right. Maintain this position for at least 45 – 60 seconds noting reports of symptoms and the latency (time to onset) and duration of those symptoms. Repeat this on the left side.

Normal test:

Abnormal test:

Clinical significance:
BPPV Treatment Laboratory

A. Canalith Repositioning Maneuver for anterior and posterior canals: See lecture handout

B. Repositioning Maneuver for Horizontal Canal BPPV- see lecture handout
   i. Barbecue Spit Maneuver

   1. The patient sits with the head straight ahead
   2. The patient is quickly moved into the sidelying position on the unaffected side and remains there until the nystagmus stops plus 1 minute (~2 minutes total)
   3. The patient’s head is then turned very quickly 45° downward. This position is maintained for 2 minutes.
   4. The patient can then return slowly to sitting.
   5. The maneuver is repeated to see if the patient is symptom free; if the patient still has symptoms the maneuver is repeated. Appiani et al 2001

   ii. Appiani Maneuver

   1. The patient sits with the head straight ahead
   2. The patient is quickly moved into the sidelying position on the unaffected side and remains there until the nystagmus stops plus 1 minute (~2 minutes total)
   3. The patient’s head is then turned very quickly 45° downward. This position is maintained for 2 minutes.
   4. The patient can then return slowly to sitting.
   5. The maneuver is repeated to see if the patient is symptom free; if the patient still has symptoms the maneuver is repeated. Appiani et al 2001
2. Cawthorne-Cooksey Exercises for Patients with Vestibular Hypofunction

A. In Bed
   1. Eye Movements – at first slow, then quick
      a. Up and down
      b. From side to side
      c. Focusing on finger moving from 3ft to 1 ft away from face
   2. Head movements at first slow, then quick; later with eyes closed
      a. Bending forward and backward
      b. Turning from side to side

B. Sitting (in class)
   1. and 2. as above
   3. Shoulder shrugging and circling
   4. Bending forward and picking up objects from the ground

C. Standing (in class)
   1. as A1 and A2 and B3
   2. Changing from sitting to standing position with eyes open and shut
   3. Throwing a small ball from hand to hand (above eye level)
   4. Throwing ball from hand to hand under the knee
   5. Changing from sitting to standing and turning round in between

D. Moving about (in class)
   1. Circle round center person who will throw a large ball and to whom it will return
   2. Walk across the room with eyes open and then closed
   3. Walk up and down slope with eyes open and then closed
   4. Walk up and down steps with eyes open and then closed
   5. Any game involving stooping and stretching and aiming such as skittles, bowls, or basketball

Diligence and perseverance are required but the earlier and more regularly the exercise regimen is carried out, the faster and more complete will be the return to normal activity.

3. Gaze Stability Exercises

EXERCISES TO ENHANCE VESTIBULAR ADAPTATION

1. Vestibular Stimulation (x1 viewing)
   TO BE PERFORMED 3x/DAY

   1. Hold a business card in front of you so that you can read it.
   2. Move your head back and forth sideways (about 30 degrees from center),
      keeping the words in focus.
   3. Continue to do this for 1 minute. This can be timed using a digital kitchen timer
      or microwave.
   4. Repeat this moving your head up and down.
   5. Begin with slow head movements and increase speed as tolerated,
      remembering to keep words in focus.
   6. Perform this exercise ________ Sitting
      ________ Standing with feet ______________
   7. Perform this exercise using a large pattern such as busy wrapping paper, tall
      brick fireplace, vertical blinds or checkerboard 4-6 feet in the background.

2. Visual Vestibular Interaction (x2 viewing)
   TO BE PERFORMED 3x/DAY

   1. Hold a business card in front of you so you can read it.
   2. Move the card and your head back and forth horizontally in opposite directions,
      keeping the words in focus.
   3. Continue to do this for 1 minute. This can be timed using a digital kitchen timer
      or microwave.
   4. Repeat this moving your head up and down.
   5. Begin with slow head movements and increase speed as tolerated,
      remembering to keep the words in focus.
   6. Perform this exercise ________ Sitting
      ________ Standing with feet ______________
   7. Perform this exercise using a large pattern such as busy wrapping paper, tall
      brick fireplace, vertical blinds or checkerboard 4-6 feet in the background.

Adapted from Herdman, SJ, “Assessment and Treatment of Balance Disorders in the Vestibular Deficient Patient”
4. Postural Stability Exercises

POSTURAL STABILITY EXERCISES

The purpose of these exercises is to improve your use of balance strategies and to force you to develop strategies of performing daily activities even when deprived of vision, proprioception or normal vestibular inputs. The activities are designed to help you develop confidence and establish your functional limits. On all of these exercises you should take extra precautions so you do not fall. You may stand in front of a wall with a chair in front of you for security but try not to use your hands for support. During the exercises with your eyes closed mentally visualize your surroundings.

1. Stand with your feet as close together as possible. Stand with your eyes open, count to 30 slowly. Stand with your eyes closed, count to 30 slowly.

2. Stand with one foot in front of the other, heel to toe, count to 30 slowly. Switch feet and count to 30 slowly. Once you can do this with your eyes open try it with your eyes closed.

3. Practice standing on one foot, count to 30 slowly. Switch feet and count to 30 slowly. Once you can do this with your eyes open try it with your eyes closed.

4. Stand on a foam pillow with feet shoulder width apart. Stand with your eyes open, count to 30. Stand with your eyes closed for a count of 30. Once you are able to perform this easily stand with your feet close together.

5. Step over a 2x4 with both feet, forwards and backwards. 10 times leading with each foot.

6. Walk near a wall, walk with your eyes closed for 1-2 minutes.

7. Walk near a wall, walk with a progressively more narrow support finally walking heel to toe. Practice walking for 1-2 minutes.

8. Walk near a wall and turn your head to the right and to the left as you walk. Try to focus on different objects as you walk. Gradually turn your head faster and more often. Practice for 2-3 minutes.

9. Practice turning around while you walk. At first turn in a large circle and gradually make smaller and smaller turns. Be sure to turn in both directions.

10. Take 5 steps and turn around to the right (180 degrees) and keep walking. Take 5 more steps, turn left (180 degrees) and keep walking. Repeat 5 times. Repeat.

11. Stand on an incline or a wedge. Practice standing with your eyes open and then closed facing in all directions. Once able to do this easily stand on a compliant foam cushion on the incline with your eyes open and closed.


5. Home exercises to decrease falling
EXERCISES TO DECREASE YOUR RISK OF FALLING

1. Tip your toes. Bring your toes up with every step you take.
2. Walk taking long strides, lift your feet up with every step, avoid shuffling.
3. Stand up tall and walk with good posture.
4. Spread your legs (10 inches) when walking or turning, to provide a wide base of support, a better stance and to prevent falling.
5. For greater safety in turning, take small but distinct steps, with feet widely separated. Never cross one leg over the other when turning. Practice walking a few yards and turn. Walk in the opposite direction and turn. Repeat this 5-10 times a day.
6. Practice swaying your body from your ankles forward, back and side to side. Repeat this with your eyes open and closed. Try to see how far you can sway without taking a step. You can stand in a corner with a chair in front of you for safety. Practice catching yourself by taking a step and not reaching for a wall or chair.
7. Swing your arms freely when walking. It helps to take body weight off the legs, decreases fatigue and loosens the arms and shoulders.
8. If getting out of a chair is difficult,
Dizziness, Imbalance, and the Cervical Spine

Differential Diagnosis

- Need to determine
  - Is the dizziness vestibular in origin?
  - If it is vestibular is it peripheral, central or both?
  - Is it a loss of function, irritative or mechanical?

Differential Diagnosis

- Peripheral Vestibular Dysfunction
  - Unilateral
    - Vestibular Neuritis, Vestibular Labyrinthitis
    - Acoustic Neuroma
    - Perilymphatic Fistula
    - Meniere's Disease
    - BPPV (mechanical)
  - Bilateral
Dizziness, Imbalance, and the Cervical Spine

Dizziness, Imbalance, and the Cervical Spine

Differential Diagnosis

- Central causes of dizziness
  - Migraine related vertigo
  - Cervicogenic dizziness
  - Central vestibular dysfunction

Differential Diagnosis of Dizziness Associated with Neck Pain

- Unilateral Vestibular Dysfunction
  - Post-traumatic Meniere's Disease
  - Perilymphatic Fistula
  - Labyrinthine concussion
  - Benign Paroxysmal Positional Vertigo
- Bilateral Vestibular Dysfunction
- Central Vestibular Dysfunction
  - Migraine-related Vertigo
  - Cervicogenic Dizziness
- Central nervous system abnormality
  \((\text{Furman and Cass 2003})\)

Unilateral Vestibular Loss

- Loss of function in the vestibular system (end organs, nerve or nuclei) on one side
  - Presentation
    - Acute: episodic vertigo, nausea, nystagmus, imbalance, disorientation, gaze instability, may or may not be accompanied by hearing loss
    - Chronic: vertigo with head turns or fatigue, gaze instability, imbalance, fatigue
  - Diagnoses
    - Vestibular Neuritis
      - Acute vestibular syndrome, without obvious cause, that occurs without auditory or neurological signs or symptoms
      - Thought to be viral involvement of vestibular nerve
    - Vestibular Labyrinthitis
      - Acute vestibular syndrome with auditory syndrome
      - Acoustic Neuroma (Schwanoma)
      - Benign tumor of the eighth cranial nerve
    - Other possible causes: Infarction of labyrinthine artery, trauma, demyelinating disease or Meniere's disease

Dizziness, Imbalance, and the Cervical Spine
VPTA 2012
Meniere’s Disease

- Presentation
  - Episodic, usually unilateral (lasts hours to days)
    - Vertigo
    - Hearing Loss
    - Tinnitus
    - Nausea
    - Aural fullness
  - Symptoms are totally reversible early in disease, gradually progress to permanent vestibular and hearing loss

- Current theory of pathophysiology
  - Swelling, or distension, of the endolymphatic compartment of the inner ear leading to rupture of membranous labyrinth resulting in transient potassium palsy of the vestibular nerve fibers

Perilymphatic Fistula

- Presentation
  - Episodic vertigo, imbalance, and sensorineural hearing loss
  - Classically a history of head trauma, barotrauma, mastoid or stapes surgery, or vigorous straining precedes onset
  - Symptoms can be elicited with val salva maneuver

- Pathophysiology
  - Traumatic rupture of the round or oval window

Benign Paroxysmal Positional Vertigo

- Most common form of dizziness
- Presentation
  - Short duration episodic vertigo during head movements
  - May also complain of imbalance, disorientation
  - A small percentage of patients do not complain of vertigo
  - Worse in am

- Pathophysiology
  - Otoconia become dislodged from utricle and either float in endolymph of semicircular canal or attach to cupula
  - This causes the semicircular canals to respond to gravity
  - Patients demonstrate characteristic nystagmus in response to head movements in the plane of the involved canal that has a latency of 2-15 seconds and a duration of <1 minute
Atypical Positional Vertigo/Central Positional Vertigo

- Presentation
  - Atypical response to Dix-Hallpike maneuvers such as no latency, increased duration, and non-fatigability
  - Generally suggestive of a posterior fossa lesion

Bilateral Vestibular Loss

- Loss of function in the vestibular system (end organs, nerve or nuclei) on both sides
- Presentation
  - If loss is symmetric will not have vertigo
  - Generally complain of gaze instability and imbalance, especially with decreased sensory input
- Diagnoses
  - Otoxicity:
    - Aminoglycoside antibiotics
    - Long loop diuretics
    - Chemotherapeutic agents
  - Idiopathic (Dandy Syndrome)

Central Vestibular Dysfunction

- Dysfunction of the vestibular nuclei, cerebellum and other vestibular pathways
- Presentation
  - Depends on where lesion occurs
    - Less likely to have true vertigo
    - More likely to have constant symptoms
    - More likely to have balance dysfunction
    - More likely to have central nervous system signs
- Diagnoses
  - Multiple Sclerosis
    - 10-15% of patients with MS will have dizziness as their initial symptom
  - Cerebral Vascular Accident
  - Trauma
  - Cerebellar Degeneration
Migraine-associated Dizziness
- A specific form of central vestibular dysfunction
- Current theory of pathophysiology
  - Increased activity in the brainstem
  - Abnormalities in neurotransmitter levels
- Presentation
  - Dizziness may occur before, during, or after a migraine
  - Episodic vertigo, nausea, disorientation, space and motion intolerance associated with headache
  - Symptoms are often exacerbated by specific visual environments
  - Some patients can have migraine without headache, migraine equivalents, with dizziness instead of headaches

Cervicogenic Dizziness
- A specific form of central vestibular dysfunction
- Responsible for < 1% of all cases of vestibular dizziness
- Diagnostic Criteria
  - History of neck trauma or pathology
  - Symptoms of dizziness and imbalance temporally related to neck pain or headache
  - All other causes of dizziness eliminated
- Current theory of Pathophysiology
  - Aberrant afferent information from C1-C3 causes altered perception of orientation in space

Differential Diagnosis: Expected Symptoms

<table>
<thead>
<tr>
<th></th>
<th>Unilateral Peripheral Vestibular Dysfunction</th>
<th>Bilateral Peripheral Vestibular Dysfunction</th>
<th>Central Vestibular Dysfunction</th>
<th>BPPV</th>
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</thead>
<tbody>
<tr>
<td>Onset</td>
<td>Sudden</td>
<td>Sudden or gradual</td>
<td>Gradual</td>
<td>Sudden</td>
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<tr>
<td>Frequency</td>
<td>Episodic</td>
<td>Constant</td>
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<tr>
<td>Duration</td>
<td>Minutes to hours</td>
<td>Hours to days</td>
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<td>Seconds to minutes</td>
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<td>Symptoms</td>
<td>Vertigo, nausea, imbalance</td>
<td>Dizziness, imbalance</td>
<td>Lightheadedness, imbalance</td>
<td>Vertigo</td>
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</table>
Dizziness, Imbalance, and the Cervical Spine

VPTA 2012
Patient Case

- 41 year old female presents to clinic
  - Chief complaint: difficulty walking, imbalance, 2 falls in last 4 weeks
  - Symptoms started 4 weeks ago with 3 day episode of dizziness, now only has imbalance, disorientation, history of falling and difficulty walking
  - Associated symptoms of headache and neck pain
  - What is your differential diagnosis?

Patient Case

- Exam results:
  - DHI: 45/100; ABC: 53/100; VADL scale: 4
  - Strength, sensation, coordination: normal
  - Cervical ROM within normal limits but c/o increased dizziness with neck movement
  - Smooth pursuits, saccades: normal but increased symptoms
  - Head thrust: abnormal with head rotation from left to right
  - Dynamic visual acuity: acuity degrades from 20/20 to 20/60
  - Unable to stand on foam with eyes closed
  - Functional Gait Assessment: 15/30 Increased sway walking with head turns, veers to right walking with her eyes closed, unable to ambulate tandem

- What is the most likely diagnosis?
<table>
<thead>
<tr>
<th>Onset</th>
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<td>Vertigo (rotatory)</td>
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DP: Directional Preponderance

Wrisley DM 2004
Dizziness, Imbalance, and the Cervical Spine

Cervicogenic Dizziness: Vestibular and Balance Intervention

Diane M. Wrisley, PhD, PT, NCS

Suggested Treatment in Literature

- Cervical collar Cope and Ryan, 1959
- Cervical traction Mayoux et al, 1951; Jongkees, 1969
- Neck manipulation Stoddard, 1952; Ledru, 1955
- Cold spray and local anesthetic Weeks and Travell, 1955
- Local anesthetic injection and massage Gray, 1956
- Combination Manual Therapy and Vestibular Rehab Vidal 2003, Wrisley 2002

Treating at the Impairment Level

- Goals:
  - Correct temporary/changeable impairments
  - Prevent secondary impairments
  - Teach compensatory strategies for permanent impairments
  - Attempt to change impairments where not known whether permanent
  - Refer to other health care professionals as appropriate.
Vestibular and Balance Impairments
- Vestibular Ocular Dysfunction
- Ocular Motor Dysfunction
- Sensory Interaction
- Motion Sensitivity
- Balance and Gait Dysfunction
  - Sequence, timing of motor activities
  - Strength, ROM
  - Limits of stability

Treatment of Cervicogenic Dizziness
- Generally treat orthopedic impairments first
- Treat visual or ocular motor impairments
  - Saccades
  - Smooth Pursuit
  - VOR
  - Convergence dysfunction

Treatment of Cervicogenic Dizziness
- Treat any resultant space and motion discomfort and/or visual/vestibular mismatch
- Treat any remaining balance problems
  - Instruction in use of sensory information for balance
  - Instruction in use of balance strategies
  - Gait training in various environments
Vestibular Ocular Dysfunction

- Vestibular stimulation exercises
  - VOR x1
  - VOR x2
  - Progress from sitting through standing, increase demands of task
- Vary sensory conditions of task
  - Narrow base of support
  - Standing on foam
  - Busy visual background
- Ocular Motor Exercises
  - Saccades and Smooth Pursuit

Space and Motion Discomfort

- Treat any resultant space and motion discomfort or visual/vestibular mismatch
- Exposure therapy: exposure to gradually more complex visual environments
- Gaze stabilization exercises
  - VOR x1, VOR x2 with busy visual backgrounds
  - Walking with head turns, eyes closed

Treatment of Sensory Impairments

- Begin with full sensory inputs
- Graded exposure: challenge is added by gradually increasing number of sensory inputs manipulated and degree to which input manipulated.
- Vestibular inputs can be relatively isolated by manipulating both visual and somatosensory inputs. Head and eye movements can further challenge the vestibular system.
Somatosensory

• Promote use of somatosensory inputs
  • Disadvantage vision while providing reliable somatosensory input (stable surface)
  • Examples of activities
    • Standing sway exercise with eyes closed, in dimmed light or darkness
    • Sit to and from stand with eyes closed
    • Ambulation with head and eye movements
    • Conflicting visual environments: crowds, striped curtains, moving visual surrounds.
    • Rice exercise

Visual

• Promote use of visual inputs:
  • Disadvantage somatosensory input while providing reliable visual cues (stable visual field with landmarks)
  • Examples of activities:
    • Standing/sitting on rocker board, BAPS board, moving platforms
    • Standing/ sitting on compliant surface (foam)
    • Ambulate with foam boots
    • Instruct in visual fixation

Vestibular

• Promote use of Vestibular inputs:
  • Disadvantage vision and somatosensation while providing reliable vestibular cues (detectable head position)
  • Examples of activities
    • Practice standing or ambulating on unstable or compliant surface with:
      • Absent vision (eyes closed)
      • Destabilized vision (head and eye movements)
      • Confused vision (visual conflicting environment)
Dizziness, Imbalance, and the Cervical Spine

VPTA 2012

Vestibular

Examples of activities (continued)

- Difficulty can be increased by adding neck extension and rotation to place vestibular organs at disadvantage.
- Vestibular stimulation exercises may also stimulate use of vestibular inputs.

Gait Training

- Perform in various sensory environments
  - Compliant surfaces
  - Varied lighting
  - Varied obstacles
- Add head and upper extremity movements
- Add cognitive tasks

HEAD MOVEMENTS

Standing-Diagonal

Stand with your back to (but not touching) the wall. Bring your chin down and towards your left shoulder, then lift your chin up and over your right shoulder.

Do this with eyes open/closed

Hold each position for ten seconds or until symptoms decrease. Increase speed as the severity of the symptoms decrease.

Repeat ___ times a day.
What are the outcomes of vestibular rehabilitation?

- Improvements in impairments
  - Gaze Stability: Sztrum et al 1994; Bulle 2004
  - Fall risk: Herdman et al 2001


- Fall risk: Herdman et al 2001


- Space and motion dyscomfort: Whitney et al 2014

- Anxiety: Yardley et al 1998; Jacob et al 2001

- Orientation/perception of vertical: Strupp et al 1998

What are the outcomes of vestibular rehabilitation?

- Improvements by diagnosis group
  - Peripheral vestibular dysfunction
    - BPPV: Massoud and Ireland 1996; Nuti et al 2000; Cohen and Jerabek 1999; Fujino et al 1994
    - Bilateral: Brown et al 2001

- Central vestibular dysfunction
  - Anxiety: Jacob et al 2001

Customized vs generic exercise program

- Horak et al 1992
Customized vs. generic exercise program

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<th>Outcome Variable</th>
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<th>Generic</th>
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Sztrum et al 1994

Evidence for Treatment of Cervicogenic Dizziness
Cervicogenic Dizziness Treatment Outcome

- Wing et al, 1974
  - 80 subjects with history of neck pain and vertigo
  - Case series, no control group
  - Intervention: manipulation, soft collar, instruction in proper sleeping position
  - Outcome measures: ENG with head movements, subjective symptoms
  - 73% subjects improved in ENG with head movements, 53% subjects reported complete improvement, 36% had significant improvement

Treatment Outcome

- Karlberg et al, 1996
  - 17 patients with diagnosis of cervicogenic dizziness, 17 healthy subjects
  - Prospective, randomized, clinical trial
  - Intervention: manual therapy, soft tissue treatment, stabilization exercises, body mechanics instruction
  - Outcome measures: subjective intensity of pain, frequency of dizziness, postural stability
  - 82% of subjects reported subjective improvements in dizziness and neck pain, postural stability significantly improved

Treatment Outcome

- Galm et al, 1998
  - 50 patients with suspected cervicogenic dizziness: 31 with cervical spine dysfunction, 19 without
  - Case series, no control group
  - Intervention: manual therapy
  - Outcome measure: subjective improvements in dizziness
  - 77% of patients with cervical spine dysfunction had decreased dizziness, 26% of patients without cervical spine dysfunction reported decrease in dizziness.
Treatment Outcome

- Reid et al 2008
  - 34 participants with Cervicogenic Dizziness randomized to either receive 4-6 treatments of:
    - Sustained natural apophyseal glides (SNAGs)
    - Detuned laser
  - At discharge patients had less dizziness, lower DHI scores, less frequency of dizziness, decreased pain and increased ROM

Intervention

- 74-93% of people with cervicogenic dizziness who received manual therapy had a reduction in symptoms

(Reid and Rivett 2005, Galm et al. 1998; Karlberg et al. 1996; Wing et al. 1974)

Cervicogenic Dizziness

- Need to determine if there is any vestibular pathology
- Currently it is a diagnosis of exclusion
- The intervention is different based on the presenting symptoms and diagnostic test results
- The majority of symptoms of cervicogenic dizziness improve with the treatment of the neck dysfunction
- Vestibular rehabilitation techniques may be helpful in relieving residual balance and space and motion discomfort
Benign Paroxysmal Positional Vertigo

- Most common cause of vertigo (60% of vestibular dizziness)
- Results from displacement of the otoconia so that the semicircular canal becomes abnormally sensitive to gravity or linear acceleration
- First described in 1921 by Barany

Pathophysiology of BPPV (Theories)

- Cupulolithiasis (Schuknecht, 1966 and 1969)
  - Otoconia become loose from the utricle and adhere to the cupula
  - Histologic studies demonstrate degeneration of the otolithic membrane and cupular deposits

- Canalithiasis (Parnes, 1992)
  - Otoconia become loose from utricle and are free floating in the endolymph
  - Surgical and post-mortem studies have demonstrated loose otoconia in semicircular canals
Free floating Otoconia

Symptoms of BPPV

- **Primary Symptoms**
  - Vertigo or dizziness related to changes in head position
- **Secondary symptoms**
  - Imbalance
  - Difficulty walking
  - Lightheadedness
  - Sense of tilt
  - “Floating”
  - Falling
Etiology of BPPV

- Idiopathic (Furman and Cass, 1999)
- Post-traumatic (Katsarkas A, 1999; Gordon et al 2004)
- Post-acute vestibulopathy (Pollak et al 2002)
- Meniere's Disease (Hughes and Proctor, 1997)
- BPPV has been associated with diabetes and mild head trauma (Cohen et al 2004)
- Whiplash: cause of vertigo in 34% patients with whiplash (Dipenzia et al 2011)

Provoking Positions

- Getting out of bed
- Lying down from sit to supine
  - Inability to sleep without the head of the bed raised
- Bending over
- Looking up or reaching overhead
- Rolling in bed
- Going from supine to sit

Diagnostic Criteria for BPPV

- Vertigo associated with characteristic nystagmus provoked by Dix-Hallpike or Roll test
- Onset latency of symptoms of < 5 seconds – 1 minute
- Vertigo and nystagmus lasting < 60 seconds
- Crescendo and decrescendo of nystagmus and vertigo
- Symptoms extinguish with repeated movement into the provoking positions
Dizziness, Imbalance, and the Cervical Spine

Tests to Diagnosis BPPV

• Dix Hallpike test for posterior and anterior canal BPPV
  • Developed in 1950’s
  • Considered the “gold standard” for BPPV (Nunez et al 2000)
  • Psychometrics:
    ▪ Sensitivity: 79%, Specificity: 75%, + LR: 3.17, -LR:0.28, overall accuracy: 79% Halker et al 2008
    ▪ Using Prevalence of 88%: + post-test probability = 96%; - post-test probability = 67%
    ▪ May result in false negatives if it is not repeated (Virre et al, 2005)

• Roll Test for horizontal canal BPPV

Dix-Hallpike Maneuver

• With the patient in long-sitting, their head is turned 45 degrees toward the ear being tested
  • The patient is brought back into supine with the head extended 30° over the edge of the bed.


Posterior Canal Involvement

• Nystagmus is paroxysmal and ipsilateral torsion and upbeatng (quick phase is beating upwards toward the involved ear)
Anterior Canal Involvement

- Nystagmus quick phase is ipsilateral torsion and downbeating (quick phase is beating downward towards the involved ear)

Do you have to see torsional eye movements?

- Haynes et al (2002) coined the term "subjective" BPPV
- 90% of persons with "objective" BPPV improved and 87% of those with "subjective" BPPV improved

So, do you have to see torsional upbeating nystagmus to resolve BPPV in your patients?

Frenzel goggles
What systems need to be checked before testing for BPPV?

- Clear cervical spine
- Ocular motor function
- Vestibular Ocular Reflex
- Vertebral artery test (?)

The Roll Test

Begin with the patient supine and the head in midline. Tilt the head up 30° in midline.
Roll head quickly to one side, observe for nystagmus, ask patient to report symptoms.

**Horizontal Canal Involvement:**

**Canalithiasis in posterior arm**

- **Nystagmus:** Horizontal direction-changing, nystagmus directed toward the undermost ear on both sides and more intense when turned toward the affected side. Non-fatigueable with repeated testing.
- **Latency:** Minimal
- **Duration:** < 1 minute

**Horizontal Canal Involvement:**

**Canalithiasis in Anterior Arm**

- **Nystagmus:** Horizontal direction-changing, nystagmus directed toward the uppermost ear on both sides and more intense when turned toward the unaffected side. Non-fatigueable with repeated testing.
- **Latency:** Minimal
- **Duration:** ~ 1 minute
Horizontal Canal Involvement: Cupulolithiasis

**Nystagmus:** Horizontal direction-changing nystagmus directed toward the uppermost ear on both sides and more intense when turned toward the unaffected side. Non-fatigable with repeated testing

**Latency:** minimal

**Duration:** non-fatigable

Treatment of Benign Paroxysmal Positional Vertigo

- The Single Treatment Approach
  - Canalith Repositioning Maneuver (Epley Maneuver) for the Posterior or Anterior Canal
  - Liberatory Maneuver (Semont Maneuver) for Posterior or Anterior Canal
  - Roll Maneuver for the Horizontal Canal
  - Apiani Maneuvers for the Horizontal Canal
  - Forced Prolonged Positioning for Horizontal Canal
- Exercise Approach
  - Brandt-Daroff Exercise for Posterior or Anterior Canal
  - Roll Exercise for Horizontal Canal

Are the CRM and Liberatory Maneuvers Equally Effective?

- The CRM and Liberatory maneuvers have been shown to be equally effective in randomized clinical trials
  
  Massoud et al, 1996; Cohen and Jerback, 1999; Aranda-Moreno and Jauregui-Renaud, 2000
The Canalith Repositioning Maneuver (Epley, 1992)

- 5 position cycle
- repeated procedure until symptoms resolved
- used vibrator to help disperse particles
- relatively upright for 48 hours
- 80% initial cure rate - one visit
- 20% cure rate with more than one visit
- 30% recurrence rate

Modified Canalith Repositioning Maneuver

1. Begin in end position of Dix-Hallpike

![Diagram A](image)


2. Turn head slowly to opposite direction, in 30° of extension

![Diagram B](image)

Modified Canalith Repositioning Maneuver
3. Roll to nose down position


Keys to successful repositioning

- Brisk Hallpike maneuver
- Hold each position until the nystagmus and symptoms end or as long as first position held
- Vertex of head must stay dependent throughout repositioning maneuver
- Move to the upright position without returning to supine
- Vibration of the mastoid has not improved outcomes
- Repeated repositioning within one session provides superior results to a single physical maneuver (Gordon and Gadoth, 2004)
Instructions following CRM

- Avoid fast head movements
- Keep head upright for 48 hours
- Do not lie on affected side for 48 hours

Are these precautions necessary?

Need to stay upright following repositioning

- Multiple studies have shown no difference in outcome following either the Epley or Semont maneuver whether instructed to keep head upright for 48 hours or to avoid brisk head movements for 1 week (Massoud and Ireland, 1996; Nuti et al, 2000; Cohen and Jerabek, 1999)
- Meta-analysis found no need for post-maneuver restrictions (Mostafaei et al 2012)

Outcomes after CRM

- 36 subjects with BPPV of 2 months duration were assigned to either a CRM or a placebo maneuver.
  - At 1 month follow-up
    - CRM group: 89% had negative Dix-Hallpike
    - Placebo group: 27% had negative Dix-Hallpike (Lynn et al, 1995)
  - 124 subjects with BPPV randomly assigned to CRM or sham group
    - At 30, 60, and 210 day follow-up
      - CRM group had significantly less intensity and frequency of vertigo compared to sham group (Cohen and Kimball, 2005)
Horizontal canal CRP
Lempert or Barbecue Maneuver

A. The Patient is seated
B. The patient is quickly brought down into side-lying position on the unaffected side and stays in position 2 minutes
C. The patient quickly turns their head 45° downward and stays in the position for 2 minutes
D. The patient returns to the seated position

Horizontal Canal CRP
Canalithiasis in posterior arm

A. The Patient is seated
B. The patient is quickly brought down into side-lying position on the unaffected side and stays in position 2 minutes
C. The patient quickly turns their head 45° downward and stays in the position for 2 minutes
D. The patient returns to the seated position
E. If successful the debris are in the posterior arm and immediately treated with the other maneuver

Horizontal Canal CRP
Canalithiasis in anterior arm or cupulothiasis

A. The Patient is seated
B. The patient is quickly brought down into side-lying position on the affected side and stays in position 2 minutes
C. The patient quickly turns their head 45° upward and stays in the position for 2 minutes
D. The patient returns to the seated position
E. If successful the debris are in the posterior arm and immediately treated with the other maneuver
Outcomes for Horizontal Canal BPPV

Barbecue or Lambert Maneuver
- RCT: In patients with geotropic HC-BPPV 69% improved with barbecue rotation, 61% improved with Gufoni, 35% improved with sham. Kim et al 2002
- RCT: No significant difference in time of recovery between subjects who received CRP and those who did not. Sekine et al 2006
- Non-RCT: 74% of 46 patients cured after 1 procedure; 85% in < 4 procedures. Escher et al 2007

Gufoni (Appiani) Maneuver
- Canalithiasis in posterior arm:
  - Non-RCT: 100% of 32 patients were cured after 2 treatments. Appiani et al 2001
- Canalithiasis in anterior arm or Cupulothiasis:
  - Non-RCT: 17% of 41 patients cured, 66% transformed to geotropic and no change in 17%. Gufoni et al 1998
  - Non-RCT: 50% of 8 patients transformed to geotropic and 50% no change. Appiani et al 2005

Repeated Exercise Approach
- Brandt Daroff exercise (sit and lean)
  - For Posterior or Anterior canal
- Rolling exercise
  - For Horizontal canal
- May take 5-10 reps 3 times a day for 2 weeks to see improvement
- Exercise may increase symptoms and compliance may be an issue
Brandt-Daroff Exercises

Outcomes of CRM versus Brandt-Daroff Exercises

- Cure rate after 1 week
  - Brandt-Daroff: 24%
  - CRM: 71%
  - Liberatory: 74%
- After 3 months
  - Brandt-Daroff: 62%
  - CRM: 93%
  - Liberatory: 77%

(Soto Varela et al, 2001)

Outcomes of CRM versus Brandt-Daroff Exercises

- 125 subjects randomized to 5 groups
- Subjects who underwent single treatment had fewer symptoms but did not reach statistical significance

(Cohen and Kimball, 2005)
Difficulty in Diagnosing BPPV

- 33% of patients had experienced BPPV symptoms for more than 1 year. Baloh and Honrubia (1998); Welling and Barnes (1994)
- Results of the Dix–Hallpike can be affected by the speed of the maneuver, the plane of the occiput, and the day to day variability. (Nunez et al, 2000)

Difficulty in Diagnosing BPPV

- Patients may need to be examined more than once to confirm diagnosis – BPPV is not always easily confirmed during the clinical exam. (Norre’, 1994)
- Performing the Dix–Hallpike once, then the roll test, then repeating the Dix–Hallpike decreases chance of misdiagnosis (Verve et al, 2005)

Bilateral BPPV

- Suggested that bilateral BPPV is always of the posterior canal (Katsarkas, 1999)
- 6% bilateral posterior canal BPPV, 3% multiple canal (Balatsouras 2012)
- Trauma is the most common cause of bilateral BPPV (Pollak et al, 2006; Katsarkas, 1999)
- No difference in outcomes between those with unilateral or bilateral BPPV (Pollak et al, 2006)
Recurrence of BPPV Symptoms

- Recurrence rate was 26.8% in persons who initially had complete resolution of their symptoms
- Suggest a 15% recurrence rate per year and a 50% recurrence rate within 40 months of treatment
- Age, sex, duration of sx, cause, or physician did not affect the recurrence rate

(Nunez RA, Cass SP, Furman JM. Otolary-Head and Neck Surg 2000;647-652.)

Options for managing recurrent BPPV

- Repeat particle repositioning when needed
- Teach the patient or the family member to self treat (you must be very careful with this)
- Canal occlusion surgery

Familial Incidence of BPPV

- Surveyed 120 successive patients seen with BPPV
- Also surveyed 120 patients with dizziness with no BPPV
- Patients with BPPV were 5 times more likely to have relatives with a history of BPPV than the dizziness group without BPPV (Gizzi et al, 1998)
Unrecognized BPPV in the Elderly
- 100 consecutive patients referred to geriatric clinic
- Age range was 51-95 (mean 74)
- Dizziness was reported by 61% of the older adults although they were not seeking intervention for dizziness
- Balance disorders were noted in 77% of the patients
- 9% of these subjects had unrecognized BPPV

Oghalai JS et al, May, 2000

Postural Control After Repositioning
- Posturography scores in 32 subjects with BPPV were decreased on conditions 2-6
- The patients continued to have deficits in postural control at 3 days and at 3 months compared to controls (DiGirolamo et al, 1998)
- Prospective trial with 33 subjects with posterior canal BPPV
  - All subjects had resolution of their vertigo
  - Not all subjects had normal CDP
  - Younger subjects more likely to have normal CDP (Blatt et al, 2000)

Quality of Life and BPPV
- Quality of life scores in people over the age of 60 are reduced
- Quality of life scores improve after repositioning

(Gamiz and Lopez-Escamez, 2004)
Summary

- BPPV occurs frequently and is a common complaint in acute care, outpatient, home care, and inpatient rehabilitation.
- The evidence for evaluation and treatment of BPPV is constantly changing.
Cases for Problem Solving

**Case 1**

- **History**
  - 34 year old woman who worked as secretary
  - 18 month history of dizziness
  - Symptoms consist of:
    - Episodic
    - Severe vertigo
    - Unilateral hearing loss
    - Tinnitus and fullness
    - Blurred vision and imbalance during attacks
    - Increased symptoms with rapid head movements

  What additional history information would you like?  
  What is your differential diagnosis?

- **History continued**
  - No symptoms between attacks except for mild hearing loss, mild dysequilibrium, tinnitus.
  - No weakness, numbness or other neurological complaints.

- **Differential Diagnosis**
  - Peripheral vestibular abnormality suggested – **WHY?**
  - What specific diagnosis suggested?

- **What evaluation techniques would you use or recommend for this patient?**

**Case 2**

- **History**
  - 45 year old male attorney
  - 6 week history of dizziness
  - Symptoms consist of:
    - Dizziness when rolling over in bed to right or when reaching over his head
    - 1 day episode of severe vertigo, nausea, and vomiting that occurred 2 months before evaluation
    - Several days of vertigo and imbalance following acute episode

  What additional information do you need?  
  What is your differential diagnosis?
Case 2

- History continued
  - Almost entirely asymptomatic at rest but continuing to report positional symptoms
  - No hearing loss

- Differential Diagnosis

Case 2

- What evaluation techniques would you use or recommend for this patient?

Case 2

- What would you expect to see on vestibular and balance testing?

Case 3

- History
  - 70 year old male
  - 6 week history of episodic dizziness
    - Symptoms:
      - Occur about 2 times per week
      - Acute onset of vertigo
      - Tendency to fall to right
      - Last seconds to minutes

- What additional information do you need?
- What is your differential diagnosis?

Case 3

- History continued
  - Circumoral paraesthesias during vertiginous episodes
  - Double vision during one occasion
  - Family related that during some episodes speech was difficult to understand and patient had difficulty walking

- How does this influence your differential diagnosis?
Case 3
- What evaluation techniques would you use or recommend for this patient?
- What would you expect to see on vestibular and balance testing?

Case 4
- History
  - 49 year old delivery van driver
  - 5 month history of dizziness and lightheadedness
  - Symptoms:
    - Fluctuate daily
    - Exacerbated by head movements

What additional information do you need?
What is your differential diagnosis?

Case 4
- History continued
  - Onset of symptoms related to occurrence of MVA, where he was struck from rear causing flexion/extension, whiplash, injury
  - Symptoms are temporally related to neck pain
  - No significant medical history
  - Differential Diagnosis

Case 4
- What evaluation techniques would you use or recommend for this patient?
- What would you expect to see on vestibular and balance testing?
Case 5

History
- 28 year old female (Accountant) with complaints of HA x 3 weeks
- Symptoms:
  - Pain continuous (2–7/10) in L occipital and temporal region
  - Increases at work; decreases when lays down
- No history of trauma

What additional information do you need?
What is your differential diagnosis?

History continued
- Occasional HA in the past (1x/mo), last < 3 hrs and gone w/ Motrin
- No currents meds; tried Naproxen but was not beneficial
- Unremarkable medical history

Differential diagnosis

What evaluation techniques would you use or recommend for this patient?

Do you recommend specific vestibular or balance testing for this patient?

QUESTIONS?