## Integrated Control of Stability and Movement: Perspectives from Orthopedics and Geriatrics

Friday, February 3, 2006  
8:00 AM – 11:00 AM  
Course Level: Multiple Level – 0.28 CEUs

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Physical therapists assess and treat a wide variety of movement disorders. Central to our work is an integrated understanding of the nervous system, the musculoskeletal system, and the person as a whole. This session will begin with an update on the control of movement, emphasizing neurophysiological mechanisms for control of stability and mobility. Clinical examples to follow will demonstrate integrated treatment approaches for low back pain, shoulder impingement, prevention of falls in older adults, and treatment for cervicogenic dizziness. Throughout the program, attendees will learn how a firm understanding of motor control and motor learning can be applied to physical therapy. A speakers’ roundtable will offer the audience opportunities to pose their own clinical questions on topics related to the session.

This handout contains 21 pages, including this title page. The handout is broken into five sections, one for each speaker; learning objectives are provided for each section.

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**Summary.** Understanding movement requires an integrated understanding of the musculoskeletal and central nervous systems. The major descending systems for motor can be divided into lateral and ventromedial systems. Lateral systems focus on fine control of individual body segments, especially distal segments. Ventromedial systems focus on gross control of posture and whole-body movement patterns, especially axial and proximal segments. Understanding motor control provides insight into the most effective ways to help patients learn exercises for purposes such as stability versus fine control. Integrating that understanding with principles of motor learning should be at the core of the physical therapists thought process for any rehabilitation program.

**Objectives**
At the conclusion of the program, you will be able to:
1. Analyze the contributions of the major descending systems for motor control to stability and mobility for movements such as gross mobility, locomotion, and reaching.
2. Apply principles of motor control and motor learning to the design of effective physical treatments

**Outline**

- **Descending Systems for Motor Control**
  - A descending system is another name for a motor tract.

  A descending system is:

  - The major descending systems can be divided into lateral systems and ventromedial systems. ¹
    - Lateral Systems: Corticospinal Tracts, Rubrospinal Tract (Fig 1A)
    - Medial Systems: Reticulospinal Tracts, Vestibulospinal Tracts (Fig 1B)

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¹ The major descending systems can be divided into lateral systems and ventromedial systems. Lateral systems focus on fine control of individual body segments, especially distal segments. Ventromedial systems focus on gross control of posture and whole-body movement patterns, especially axial and proximal segments. Understanding motor control provides insight into the most effective ways to help patients learn exercises for purposes such as stability versus fine control. Integrating that understanding with principles of motor learning should be at the core of the physical therapists thought process for any rehabilitation program.
Figure 1. Lateral (A) and Ventromedial (B) descending systems for motor control. Legend on preceding page.
Figure 2. Schematic of interneuronal networks in the spinal cord. On the left, major regions within the spinal grey are indicated. Motor pools and networks for control of limb muscles and distal muscles of the hands and feet are lateral in the ventral horn. Motor pools and networks for control axial and proximal limb muscles are medial in the ventral horn. Comparing this to the distributions of the descending systems in Fig. 1 shows why lateral systems influence distal muscles and ventromedial systems influence proximal muscles. Networks of interneurons in the spinal grey help distribute descending commands to form functional synergies throughout the limbs and between sides of the body. In this schematic example, red solid lines represent excitatory connections from interneurons to motor pools, blue dashed lines represent inhibition; line thickness represents the strength of the connection. Descending systems rely heavily on spinal networks for control of functional movement patterns. For distal limb muscles, lateral systems such can exert direct control over motoneurons for isolated control of individual joint movements, but even these monosynaptic connections are a complement to broader control from spinal networks, not a substitute. Ventromedial systems also employ a combination of control through interneurons and direct connections with motoneurons, but their focus is axial and proximal limb muscles. In this example, the rubrospinal fiber would tend to recruit distal extensors, inhibit distal flexors, and also recruit proximal extensors. The reticulospinal fiber would tend to recruit ipsilateral flexors and contralateral extensors. These are selected examples; other patterns are possible from each system. The main point of the diagram is to represent the ability of interneuronal networks to produce a pattern.

- Many aspects of muscle synergies and movement patterns are organized by the spinal cord
  - Interneurons used for proprioceptive reflexes (e.g., the stretch reflex) and cutaneous reflexes (e.g., the flexor withdrawal) are the main target of most descending systems.
  - Direct connections between “upper motor neurons” and “lower motor neurons” (alpha motoneurons) are rare and are mainly reserved for muscles of the wrist, hand, and fingers.
  - Proximal limb muscles and axial muscles are mainly controlled through interneuronal networks in the spinal cord.
Discrete movements like reaching and grasping require simultaneous, integrated control
- Corticospinal: direction of reach\(^7\) & details of hand and finger movements\(^{11-13}\)
- Rubrospinal: integrate cortical and cerebellar commands to coordinate intersegmental
dynamics of muscles throughout the limb during movement\(^{14-22}\)
- Reticulospinal: provide anticipatory postural adjustments and proximal stability to support
movement of the limb and hand\(^{23-29}\)
- Vestibulospinal: provide postural reactions to maintain gaze direction and postural control in
spite of the destabilizing influence of movement\(^1,23,27,30,31\)

Locomotion depends on central pattern generators (CPGs)
- Interneuronal networks in the spinal cord produce a basic rhythm and pattern that produces
alternating flexion and extension in one leg\(^{32-35}\)
- Commissural interneurons make the legs cycle out of phase with each other
- Descending systems activate and guide locomotion, but CPGs make the basic movements\(^{33}\)

The cerebral cortex is the source of planning and initiation of movement
- The corticospinal tract sends commands to the spinal cord to control the direction of movement
of the limb segments, and especially to control the distal segments
- Signals sent in parallel activate brainstem and cerebellar circuits to provide postural
reactions and gross motor control in support of the movement.
- Feedback during the movement is anticipated and the appropriate reaction to feedback is a
part of the initial motor plan.
- Collaterals from the corticospinal tracts and direct cortical projections are sent to the red
nucleus and to the reticulospinal system to engage these systems for motor control
- The vestibulospinal system is not directly controlled from the cortex; it depends on the
cerebellum and vestibular inputs to produce automated reactions

Normal movement requires integrated control from all the descending systems

**Principles of Motor Learning – Integration and Applications**
- Motor Learning Requires Three Things\(^{36}\)
  - Objective
  - Practice
  - Feedback

Effective movement instruction must address each of these elements
- For distal segment control, the goal should be expressed as a movement direction or as a
parameter matching intrinsic proprioceptive senses (position and force).
- For proximal and axial muscles, patients will need more practice and augmented feedback
because the accuracy of their control is less, as is the accuracy of their intrinsic feedback.
Movement objectives require care to specify in an understandable way.
- Teaching patients to perform or visualize limb movements that would naturally
engage the proximal and axial muscles is likely to be more effective than having
them try to think directly in terms of specific recruitment of the proximal
muscle.
Reference List


Ref Type: Abstract

(29) Sprague JM, Chambers WW. Control of posture by reticular formation and cerebellum in the intact, anesthetized and unanesthetized and in the decerebrated cat. Am J Physiol. 1954;176:52-64.


**Integrated Control of Stability and Movement:** Perspectives from Orthopedics and Geriatrics  
**APTA CSM 2006, San Diego, Friday, 2/3/05, 0.28 CEUs**

**Spinal Stability: Learning to Move Safely Again**  
**Speaker:** Deborah Givens Heiss, PT, PhD, DPT, OCS, 8:30 – 9:00 AM

**Summary:** The concepts of descending control with an emphasis on the importance of intrinsic spinal muscle will be applied to an understanding of the control of stability of the low back. Our improving understanding of these mechanisms challenges us to devise better ways to retrain patients to use appropriate neuromuscular control after low back injury. Advances in treatment combining innovative motor learning approaches with real-time biofeedback imaging will be presented. Recent evidence indicating an improvement in dynamic stability will be discussed.

**Objectives:**
3. Apply principles of motor control and motor learning to the design of effective physical treatments.  
4. Analyze the contributions of selected muscles to the control of stability and mobility of the spine.

**Outline:**

- **Motor Control Dysfunction Model of Low Back Pain 1**
  - Changes in postural control strategy
    - Alterations in timing,2,3 recruitment,4-6 and force (reduced)7,8 in the trunk muscles
    - State of increased potential instability in the spine9
  - Role of deep muscles for control of intersegmental motion
    - Panjabi’s10 3 sub-systems that contribute to spinal stability.
      - passive sub-system: ligaments, disc and bone
      - active sub-system: steady-state muscle recruitment
      - neural feedback sub-system: active and voluntary response

- **Relationship of intersegmental control to lumbar stabilization**
  - Importance of multifidus as a contributor to stability
    - innervation pattern12-14
    - fiber type composition15
    - precise segmental insertions13
  - Clinical Outcomes
    - Restoration of multifidus muscle CSA and recruitment is associated with a reduction of LBP recurrence16
    - Sustained improvements in pain intensity, pain descriptor scores, and function demonstrated with chronic LBP and radiographic evidence of lumbar spondylosis or spondylolisthesis17

- **Postural Control Changes occur with Stabilization Training in Healthy Controls**
  - Webber and colleagues18 showed that instruction in trunk stabilization altered the kinematics of subjects when performing upper and lower body movements
  - Scannell and McGill19 demonstrated that exercise training for 12 weeks "improved" lumbar posture as measured by changes in passive tissue stiffness and angular deformation during activities of daily living
Granata and colleagues\textsuperscript{20} found changes in postural stability of the trunk in subjects who performed stabilization exercises every day for 12 weeks. The intervention group demonstrated reduced CoP movement amplitude but larger total CoP path length traveled per second, indicating tighter neuromuscular control demonstrated by reduced torso sway and faster response time.

\textbf{Motor Learning Principles for Recruitment of Lumbar Multifidus}

- Isometric and isolated recruitment of multifidus is reported to require weeks to learn\textsuperscript{17,21}
- Tendency in clinical practice is to use too much feedback when patients learn motor skills—enhances performance but may not best facilitate retention (learning)\textsuperscript{22}
- Varying the frequency or amount of feedback improves retention of the motor skill
- Motor skill learning occurs in stages\textsuperscript{23,24}
  - Cognitive
  - Associative
  - Autonomous

\textbf{Application of Principles for Learning to Recruit the Lumbar Multifidus}

See poster presentation on Feb 4 regarding this work Sanchez WJ, Heiss, DG, Basso DM, Sachs L. A Motor Learning Study Comparing Constant to Variable Feedback using Ultrasound Imaging for Lumbar Multifidus Recruitment.

- Research Design
  - 28 subjects (age 19-47 yr) without a history of LBP
  - Two groups: Constant real-time visual feedback during training (CON) and variable feedback (VAR) from video recordings during training
  - 4 weeks of training at a schedule of 2x/week
  - Retention tested at 1 week (short-term) post training and ≥ 1 month (long-term)

- Outcomes
  - Performance variability decreased over time (stages of learning)
  - During training, VAR group had greater success with recruitment than the VAR group, as expected
  - Retention tests showed an interaction between the group and time – CON group’s performance declined and VAR group improved

- Conclusions
  - Healthy controls learned to recruit the multifidus in < 4 weeks
  - VAR training enhanced retention
  - Future research to address symptomatic subjects – those with LBP may have issues (e.g. pain or fear) that impact learning this motor skill

\textbf{Other Motor Learning Methods Applicable to Lumbar Stabilization Training}

- Random versus Blocked Practice: Contextual interference
- Transfer of Training
Reference List


Control of Reaching. Scapular Kinematics and Causes of Impingement.  
John D. Borstad, P.T., Ph.D., 9:00 – 9:30 AM

Summary: The normal biomechanics and motor control of reaching will be described. The importance of scapular stability for functional mobility of the distal segment will be emphasized. Changes in the movement system associated with impingement will be identified. Restoration of proper biomechanics through treatments applied with a motor learning approach will be explained.

Objectives:
1. Describe normal scapular biomechanics during upper extremity movement.
2. Contrast scapular motor control in healthy shoulders to shoulders with impingement syndrome.
3. Evaluate evidence relative to the testing and rehabilitation of scapula stability for shoulder impingement.

Outline:

❖ Normal Scapular Biomechanics
   ➢ Kinematics: 3-D Rotations
     ➢ Upward Rotation, External Rotation, Posterior Tipping\(^1, 2, 3, 4, 5\)
       ➢ All rotations critical for maintaining subacromial space\(^6, 7, 8\)
     ➢ Measured both during arm elevation and functional tasks\(^1, 3, 4, 5, 9, 10\)
   ➢ Muscle Activation
     ➢ Onset Sequence: Deltoid, UT, Movement, SA, LT\(^11\)
     ➢ Level of Activation: Increases with arm elevation in scapular plane
       ➢ Serratus: 25% to 40% MVC\(^8\), 7% to 42% MVC\(^12\)
       ➢ UT: 15% to 25% MVC\(^3\), 7% to 27% MVC\(^12\)
       ➢ LT: 7% to 16% MVC\(^12\)
       ➢ Deltoid (anterior): 8% to 40% MVC\(^12\)
   ➢ Sensorimotor System
     ➢ Reflexes
       ➢ GH capsule stimulation elicits reflexes in shoulder muscles; Small numbers of mechanoreceptors in coracoacromial ligament, rotator cuff, and musculotendinous junction of subscapularis and supraspinatus\(^13\)
       ➢ Stimulation of coracoacromial ligament inhibits muscle activation of SA, Supraspinatus, Infraspinatus, Deltoid, UT, Lat – subjects unable to voluntarily control implying reflex\(^14\)
     ➢ Proprioception
       ➢ End Point Accuracy increased with combined visual and kinesthetic feedback\(^15\)
       ➢ Thresholds for the perception for the start of movement improved with brace on shoulder and when in 75° ER\(^16\)

❖ Scapular Biomechanics in Subjects with Impingement
   ➢ 3-D Rotations
     ➢ Decreased UR, ER, Posterior Tipping\(^3, 5, 9, 17\)
   ➢ Muscle Activation
     ➢ Increased latency of trapezius\(^18\)
     ➢ Altered protraction to retraction ratio – protraction force decreased\(^19\)
     ➢ Increased UT activation at higher elevations with 4.6 kg load\(^3\)
     ➢ Increased LT activation at higher elevations\(^3\)
- Increased onset variability of UT, SA, LT ¹¹

Sensorimotor System
- Decreased kinesthesia – increased time to perception of passive motion ²⁰

✈ Rehabilitation
- Testing scapula control and stability
  - Visual assessment
    - Dyskinesia patterns ²¹
  - Scapular position – several reliable measures, validity not demonstrated ²², ²³, ²⁴, ²⁵, ²⁶, ²⁷, ²⁸, ²⁹
  - Strength – MMT – valid for UT, LT ³⁰, HHD – reliable ³⁰, Isokinetic
  - Endurance – closed kinetic chain upper extremity stability test – reliable ³¹
- Proprioception
  - Joint position sense ¹⁵
  - Thresholds for the perception for the start of movement ²⁰

✈ Intervention
- Activities must be based on goals:
  - Increase Strength and Endurance – select exercises that isolate target muscles ³², ³³, ³⁴, ³⁵, ³⁶
  - Normalize Kinematics – weak evidence currently ³⁷, ³⁸; serratus anterior is key muscle; stretch pec minor ⁴
- Influence Sensorimotor System ³³, ¹⁵, ³⁹
  - Muscle tone and coordination affected by mechanoreceptors and nociceptors – must first break reflex activity ¹³
  - Increase muscle spindle activation and sensitivity by altering muscle lengths and adding muscle stretch ³⁹
  - Influence higher centers of CNS by selecting novel tasks that demand vigilance, offering opportunity for prediction and adaptation, and using functional, relevant tasks. ³⁹
  - Add exteroceptive signals (auditory, visual, vestibular) to proprioceptive training to create reinforcement to motor learning ³⁹
  - Bracing or taping may influence cutaneous receptors. ¹⁶

✈ Feedback
- Visual ¹⁵, ³⁹, Uhl – Closed-circuit video system, Mirrors
- Kinesthetic – Manual positioning/movement of scapula during distal tasks
- Schedule – follow motor learning principles
Reference List

(9) Borstad JD, Ludewig PM. Comparison of scapular kinematics between elevation and lowering of the arm in the scapular plane. Clin Biomech (Bristol, Avon) 2002 November;17(9-10):650-9.


Stability in Gait: Challenges of Aging
Speaker: Deb Kegelmeyer DPT, MS, GCS, 9:30 – 10:00 AM

Summary: The motor control of movement is also altered in the elderly. The year 2005 produced a national consensus to work for “Keeping Seniors Safe” and fall prevention. Physical therapists in outpatient clinics are positioned to play integral roles in this initiative. Appropriate assessment and interventions can reduce falls if they are individualized and evidence based. Aging impacts not only the musculoskeletal system but also the neurologic system. When descending control is altered function is impacted. Studies show that the ability to motor learn and to retain this learning is maintained into old-old age but the way the elderly motor learn is different than young adults.

Objectives: At the conclusion of the program, you will be able to:
1. Apply principles of motor control and motor learning to the design of effective physical treatments.
2. Apply knowledge of the impact of aging on motor control and motor learning to improving mobility in older adults.

Outline

- **Motor Learning and Aging**
  - Does aging impact motor learning?
    - Retention
    - Use of Knowledge of Results
  - Aging does impact motor learning 5
    - Time to train
    - Number of errors
  - Memory and aging – How does this impact physical therapy with the aged? 6
    - Explicit
    - Implicit
  - Upper motor neuron disease/lesions
    - Damage to the brain has a significant impact on motor learning. This impact depends on the type and location of lesion.
      - Middle Cerebral Artery CVA
      - Parkinson’s Disease
      - Alzheimer’s

- **Motor Control and Aging**
  - Central descending control
  - Peripheral nervous system
  - Ascending Sensory information
  - Musculoskeletal system

- **Fall Prevention**
  Fall Free Coalition was created in 2005 and there is a National Initiative to decrease falls in the elderly. This all comes from the “Keeping Seniors Safe Act” of 2005. Outpatient physical therapy clinics can be integral components of this initiative. Many resources are available on this web site: WWW.healthyagingprograms.com look for information under “Falls Free”
Why did Congress pass the “Keeping Seniors Safe Act” of 2005?
1. Total cost of all fall injuries for people age 65 or older was 27.3 billion in 1994, by 2020 the cost is expected to reach 43.8 billion.
2. More than 1/3 of adults age 65 and older fall each year.
3. Of those who fall 20-30% suffer moderate to severe injuries that decrease mobility and independence and increase risk of premature death.

Barriers to Fall Prevention
- Lack of awareness of fall morbidity and preventability
- Perceived lack of expertise
- Perceived lack of Medicare coverage
- Inadequate referral patterns among providers

Identifying those at risk of falling
- Screen with TUG (minimum)
- Individualized PT assessment – must include an evaluation of balance with reliable and valid balance measurement tools. Some tools that are available include the Berg Balance scale and the Tinetti or Performance Oriented Mobility Assessment (POMA).
- Assess for problems known to negatively impact balance such as:
  - DIABETES
  - Peripheral neuropathy and peripheral vascular disease
  - Total joint replacement surgery on leg in past
  - Arthritis
  - Neurologic function – screen mental status
  - Cardiovascular function – hypotensive episodes

Beneficial Interventions for Fall Prevention and Treatment of Fallers, based on the Guidelines for the Prevention of Falls in Older Persons, American Geriatrics Society, British Geriatrics Society, and American academy of Orthopaedic Surgeons Panel on Falls Prevention

Level of evidence is all B or lower. B is pretty good (A is best) any lower indicates a need to do more studies. These studies are for community dwelling individuals.
- Gait training and advice on assistive device
- Review medications
- Exercise programs with balance training as a component
- Treat postural hypotension
- Modify environmental barriers
- Treat cardiac disorders
- Family (staff if live in facility) education

Individualized Exercise program is the most effective single intervention. This decreases risk of falls by 12% and number of falls by 19% (NCOA Falls Free: Promoting a National Falls Prevention Action Plan. 2005, www.ncoa.org)

Optimal type, duration and intensity for fall prevention remains unclear
- Mackey DC 2006 found that speed of ankle response as well as strength impacts the ability to recover balance. It is not enough to do strengthening exercise – MUST retrain the motor system to integrate neural and muscular components for an effective response. Balance and Agility exercises are integral in retraining the speed of the response.
- Address underlying impairments: Strengthen weak muscles and stretch areas where joint mobility is limited. Once have done this must retrain to use in function. Consider using functional training to address underlying impairments.
- Remember: evidence shows that patients will not comply with lengthy home exercise programs. Give them 2 – 5 exercises that really get at the key elements you need them to focus on.
Studies show that doing sit to stand at table 10x every day improves function and strength in the elderly.  
Studies do not show an additional benefit in doing more than one set of 10 when doing strengthening with elderly. If you do one good set of 10 which works the client to fatigue they will get the same functional benefit as 3 sets of 10 and they will be more compliant with one set of 10.  

Those with fall history need long-term exercise and balance training (B)  
Tai Chi C’uan is promising type of balance exercise but needs further evaluation (C)  

Reference List  

7. CDC. Leading cause of Death. CDC 2005; Available at: URL: http://www.cdc.gov/ncipc/wisqars/.  
Summary: The vestibular system is intimately connected to the musculoskeletal system to provide postural stability. Cervicogenic dizziness is characterized by dizziness and dysequilibrium that is associated with neck pain in patients with cervical pathology. Differential diagnosis and evidence-based treatment of vestibular and balance impairments that improve stability and function in individuals with cervicogenic dizziness will be presented.

Objectives:
At the conclusion of the program, you will be able to:
5. Differentiate the causes and clinical presentation of cervicogenic dizziness.
6. Design an appropriate intervention program to address the vestibular and balance impairments in a person with cervicogenic dizziness.

Outline:

Definition of Cervicogenic Dizziness (cervical ataxia, cervical vertigo, cervical nystagmus)
“Symptoms of dizziness (including vertigo, dysequilibrium, and light-headedness) arising from the cervical spine”

Causes of Cervicogenic Dizziness
• Barré-Liéou syndrome (a.k.a. posterior cervical sympathetic syndrome)
  ▪ Trauma or arthritis of C3-C4 vertebrae or disks irritates the sympathetic vertebral plexus causing constriction of the labyrinthine artery and reduced circulation of the labyrinth
  ▪ Clinical presentation: dizziness, occipital headaches, nystagmus on head movement, blurred vision, tinnitus, Horner’s syndrome
  ▪ Not scientifically accepted

• Vertebrobasilar insufficiency (VBI)
  ▪ Caused by occlusion of the vertebral arteries by osteoarthritic spurs or occipitoatlantal instability
  ▪ Symptoms elicited with cervical rotation or extension (reaching for an object overhead, turning around while backing up car, cervical spine manipulations)
    • Vertigo abrupt in onset, short duration (several minutes), with or without nausea & vomiting
    • Other associated symptoms: Visual disturbances, drop attacks or weakness, unsteadiness or incoordination, and headaches
  ▪ Diagnostic test for VBI vs. BPPV: modify vertebral artery compression test; patient sits, forward flexes at hips, at same time as extending and rotating their neck. Any symptoms in this position due to VBI

• Altered proprioceptive signals from the upper cervical spine (C1-C3)
  ▪ Most often caused by whiplash from MVAs (approx. 20-58% of individuals with whiplash injury complain of dizziness, vertigo, and dysequilibrium); also reported in patients with cervical spondylosis, patients treated with cervical traction, and patients following neck trauma
  ▪ Sensory mismatch” theory: inflammation or irritation of cervical roots or proprioceptors of facet joints or cervical musculature leads to mismatch among vestibular, visual, and cervical inputs
  ▪ Evidence supporting “mismatch” theory:
    • Patients with neck pain have a reduced ability to re-assume the original position of the head after an active head movement
Injection of local anesthetics in posterior upper cervical musculature induced an ataxic gait; hypotonia of the ipsilateral arm and leg, and a strong sensation of ipsilateral falling or tilting in human.

Diagnostic Tests

- Neck torsion nystagmus test
  - (head-fixed, body turned maneuver): elicitation of nystagmus is positive test; may only be manifestation of cervico-ocular reflex.
- Smooth-pursuit neck torsion (SPNT) test
  - found to differentiate between individuals with and without whiplash with a sensitivity of 90% and specificity of 91%
  - SP eye movement test with subjects placed in neutral, turned 45° to right and to left; difference between mean gain (ratio between eye movements and target) in neutral and torsion positions is test parameter.
- Dynamic posturography:
  - Patients with chronic cervical pain and dizziness demonstrated increased sway with head neutral compared to normals, and increased sway compared to patients with chronic cervical pain and no dizziness when necks held in most painful position during Condition 4 of SOT
  - Using vibration-induced body sway (gastrocnemius ms.), individuals with suspected cervical dizziness were differentiated from patients with vestibular neuritis or controls by discriminant analysis of swiftness, stiffness, and damping parameters describing postural control.
- None of the tests are validated; each requires specialized equipment.

Physical Therapy Evaluation

- Patient History
  - Symptoms in patients with cervicogenic dizziness are typically light-headedness, dysequilibrium, cervical pain, ataxia or unsteadiness of gait, limited cervical motion, headache (occipital or bitemporal most common), or head “not being straight”.
  - Duration and frequency of symptoms with temporal relationship to neck pain: episodic lasting minutes to hours and closely associated with neck pain
  - Time and mode of onset: typically associated with injury or cervical spine disease; onset can be sudden, gradual, or occur days to years following injury
  - Conditions that exacerbate or relieve symptoms: usually increased with neck movements or neck pain and decreased with interventions that relieve neck pain
  - History of falls or balance difficulties
  - Additional symptoms
    - Symptoms suggesting CNS pathology that may need immediate medical attention: constant vertigo, facial asymmetry, swallowing and speech problems, oculomotor dysfunction, vertical nystagmus, severe HA, UMN signs and symptoms
    - Symptoms of inner ear involvement (non-emergent referral to otolaryngologist): constant dizziness, hearing loss, tinnitus, transient vertigo, ear pain, aural fullness (stuffiness in ear)
- Examination
  - Detailed upper quarter evaluation: active and passive cervical ROM, neurological examination of the upper extremities, palpation of the cervical spine musculature, segmental mobility testing of the cervical spine
  - Vision tests: vestibulo-ocular reflex (VOR) tests; check visual acuity with eye chart; problems reading chart with head movements only suggest vestibular abnormality.
  - R/O BPPV with Hallpike-Dix maneuver; if positive, treat with canalith repositioning maneuver or Brandt-Daroff exercises; if negative manage neck impairments and refer to physician for vestibular testing. If no vestibular abnormalities found, diagnosis of cervicogenic dizziness is...
made. Whether patient has vestibular disorder or cervicogenic dizziness, therapist must decide whether to co-treat or refer to vestibular rehabilitation PT
- Balance Tests

Evidence-Based Treatment

- Treatment of the cervical spine:
  - cervical spine mobilization, ROM exercises, strengthening exercises, soft tissue mobilization, thermal agents
- Treatment of imbalance or motion sensitivity:
  - head movement exercises, positioning or habituation exercises, and balance exercises
- Three clinical trials that address outcome of treatment for cervicogenic dizziness
  - Wing and Hargrave-Wilson\(^{16}\):
    • Case series; 80 subjects with history of neck pain and vertigo, 46% with neck injury were treated with cervical manipulation, immobilization in soft collar, and instruction in proper sleeping positions; 53% of patients reported complete relief of all symptoms and 36% had significant improvement.
  - Karlberg et al\(^{17}\):
    • Randomized controlled clinical trial; 17 patients with diagnosis of cervicogenic dizziness received treatment to reduce neck pain including soft tissue treatment, stabilization exercises of the trunk and cervical spine, passive and active ROM exercise, relaxation techniques, and minor ergonomic changes at work for 5-20 weeks (median number of visits=13); 82% of patients reported improvement of neck symptoms and/or dizziness and postural performance during vibration-induced body sway significantly improved following treatment.
  - Galm et al\(^{18}\):
    • Case series; 50 patients with suspected cervicogenic dizziness, 31 with cervical spine dysfunction (Group A) and 19 without (Group B) received intensive outpatient PT for up to 3 months consisting of manual therapy; 77.4% of individuals in Group A reported improvement of symptoms of dizziness, while only 26.3% of individuals in Group B reported improvement of symptoms.

Reference List


