Balance & Stabilization Training Outline

Instructor: Dr. Jay S. Greenstein, DC, CCSP, CGFI-L1, CKTP
CEO, Sport and Spine Companies
Chairman of the Board, Sport and Spine Clinical Research Foundation

Structural v. Functional Stability:

- Structural Stability: *passive mechanisms*
  - Joint capsules & ligaments
  - Joint congruency
  - Joint centration
- (optimize load & stability)
- Functional Stability: *active mechanisms*
  - Neuromuscular Activation
- Controlled by Sensorimotor System
  - Local (joint) vs. Global (whole-body) mechanisms
- Must have stabilization globally to be effective locally


Local vs. Global Stability:

- Local Stabilization - Reflexive Joint Stabilization
- Reflex loop between joint mechanoreceptors & muscles surrounding joint
  (Guanche, et al. 1995; Tsuda et al. 2001)

Local stabilization: *muscular activation, co-contraction*

  - Ankle (peroneals)
  - Shoulder (rotator cuff)
  - Knee (quads, hams)
  - Low back & neck (deep stabilizers)

- Proximal stability is required before producing maximal strength
  - Rotator Cuff
  - Unstable Surfaces

- The unconscious reaction and speed of contraction are more important than strength
  - Only 25% MVIC required to provide joint stiffness (*Hoffer, 1981*)
Global stabilization: *provides proximal stabilization through neuromuscular chains.*

- **Upper Quarter**: scapular & rib stabilization
- **Lower Quarter**: pelvic & lumbar stabilization

- Postural Stability - the ability to maintain center of gravity (COG) within the base of support (BOS)

Integration of 3 systems:

- Visual
- Vestibular
- Proprioceptive

**Modified Clinical Test of Sensory Integration of Balance (mCTSIB):**

- “Foam & Dome”
  - Evaluates sensory influence on postural stability
    - Visual System
    - Somatosensory System
  - 10-seconds each, 3 trials
  - Document Strategies

**Modified Clinical Test of Sensory Integration of Balance:**

- Sway increases with age
- Sway increases significantly on more difficult foam conditions
The Sensorimotor System: controls Functional Stability

Sensory System (Afferent System)

- “Proprioception”
- Sherrington (1906): *The sense of position, posture, and movement*
- Lephart & Fu (2000) : *The cumulative afferent neural input into the CNS*

Specialized receptors in muscles and joints send information into Central Nervous System (CNS) for processing

- Proprioceptors
- Joint mechanoreceptors
  - Capsules & ligaments
- Muscular receptors
  - Gamma motor neuron & muscle spindle
- Cutaneous receptors
  - Pressure, temperature, vibration

3 key areas of proprioception:

- Cervical spine (*Abrahams 1977*)
  - normalize head position
- SI joint (*Hinoki, 1975*)
  - facilitate kinetic chain
- Sole of foot (*Freeman & Wyke, 1964*)
  - normalize foot position
Motor System (Efferent System)

- Signals to muscle as a result of proprioceptive information & processing in CNS
  - Facilitation: Muscle Activation
  - Inhibition: Muscle Inhibition

Sensorimotor System: Feedback & Feedforward

- Feedback: regulates motor control through reflex loops
  - Mechanoreceptors & muscle spindles
- Feedforward: plans movement pattern based on past experience
  - Cortical motor programming

Functional Stability is coordinated on 3 levels:

3. **Cortical**: Motor Program
   - Purposeful movement

2. **Subcortical**: Automatic
   - Unconscious global postural stabilization

1. **Spinal Cord**: Reflexive
   - Afferent Information
   - Local Reflexive Joint Stabilization
Functional Joint Instability:

- Freeman & Wyke 1966
  - “Deafferentation”
- Repetitive ankle sprains due to proprioceptive information from damaged ankle ligaments
- Describe repetitive joint instability in presence of normal joint strength & structure

- Subjective feeling of instability or recurrent, symptomatic sprains (or both) due to proprioceptive and neuromuscular deficits (Tropp 2002)
- Common in ankle, shoulder, knee, back & neck
  - “Chronic sprains”
  - “Micro-instability”
  - “Chronic subluxation”
- Articular neurology has direct & indirect influences on muscle tone both globally & locally
  - Quad inhibition in knee effusion (Stokes & Young, 1984)
  - Multifidus atrophy & TA delay in CLBP (Hides et al. 1994; Hodges & Richardson, 1998)
  - Ankle sprains: delayed firing in ankle & hip (Bullock-Saxton, 1994; Konradsen & Raven, 1990)

- Vicious Cycle of Instability:

- Impaired Proprioception

- Loss of muscle activation (Reduced stability)
• Abnormal movement pattern

• Altered motor program

• Joint Dysfunction

• Freeman & Wyke 1966:
  o Used wobble board training to reduce sprains
  o Significant reduction in sprains after training
  o Postulated that training compensated for a peripheral sensory deficit

• Balance & Stabilization Training

EMG Clinical Research shows that Balance & Stabilization Training:

• ↑ proprioceptive input,
• ↑ speed of contraction,
• ↑ motor output

• Arokski et al. 1999
• Balogun 1992
• Beard et al. 1994
• Blackburn et al. 2002
• Bullock-Saxton et al. 1993
• Clark et al. 2005
• Eils et al. 2001
• Heitkamp et al. 2001
• Ihara & Nakayama 1996
• Lanza et al. 2003
• Linford et al. 2006
System of Progressive Balance Training: Stability Trainers

• Thera-Band® Balance Boards
  o Neutral stance in 3 axes of rocker board while maintaining stable foot & pelvis
  o Small movement of board simulates walking on uneven ground, stimulating automatic balance reactions


• Sitting on Unstable Surfaces: O’Sullivan et al. 200
  o Compared EMG and spinal motion while sitting on stable & unstable surfaces
  o Found increased spinal motion on unstable surface, but no increase in EMG
  o Noted deeper postural muscles may be involved in making postural adjustments

• Squatting on Unstable Surfaces:
  o EMG higher in stable vs. unstable condition; EMG decreases (~35%) in quads and increases in trunk
    ▪ Anderson & Behm 2005; McBride et al. 2006
  o Good for trunk stabilization but not for leg strength training
Balance Sandals: Developed by Dr. Janda in 1970’s
- Improves muscle activation
- **hip** (Bullock-Saxton et al. 1993; Myers et al. 2003)
- **lower leg** (Blackburn et al. 2003; Lanza et al. 2003)
- Improves balance (Michell et al. 2006)

Ankle Rehab EMG: Blackburn et al. 2003
- Foam
- T-Band Kicks
- Balance Sandals

Sensorimotor Training: increases muscle activation and reduces injury risk through improving proprioception, strength, & postural stability.

Ankle Instability

ACL / Knee

Shoulder Dislocation Rehab (Naughton et al. 2005)
- 10 minutes, 5-6 days per week for 1 month
- Significant improvement in shoulder proprioception compared to control group
SMT Outcomes for Injury Prevention: Balance boards & foam surfaces

- ↓ risk ACL injury
  - Caraffa et al. 1996; Cerulli et al. 2001; Myklebust et al. 2003

- ↓ risk ankle sprains
  - Tyler et al. 2007; Clark et al. 2005; van der Wees 2006; Verhagen et al. 2005

- ↓ risk sport-specific (soccer, handball, volleyball) injuries

- Improved jump landing control in females
  - Kean et al. 2006

Prevention of Ankle Injuries in Football Players: Tyler et al. 2007

- 77% reduction in ankle sprains
- At-risk players
  - History of sprain
  - Overweight
- Blue Stability Trainer protocol
  - 5 minutes each leg
  - 5d/wk x 4 weeks pre-season
  - 2d/wk in-season
SMT vs. Strength Training:

- SMT more effective at improving function & muscle reaction in ACL Rehab  
  - Beard et al. 1994; Pavlu et al. 2000
- SMT increases back strength and reduces postural sway compared to trunk strengthening, which increases postural sway  
  - Kollmitzer et al. 2000
- SMT improves muscle balance and strength significantly more than strengthening alone  
  - Heitkamp et al. 2001

Balance & Stabilization Training: Clinical Applications

- Sensorimotor Training Progression- Dr. Vladimir Janda (1928-2002)
- Maximize Proprioception
- Facilitate muscle activation
- Restore movement pattern
- Re-program motor program
- Improve joint function
- Sole of foot is an important source of proprioceptive information
- proximal stability - Integrate movement of extremities with stable trunk

Functional Exercise Progression:

1. Restore normal joint proprioception & movement patterns
   a. Control pain & inflammation
   b. Facilitate “proprioceptive” posture
   c. Restore normal joint biomechanics
2. Increase sensory input
   a. Conscious awareness of movement & position
   b. Stimulation of proprioceptors
3. Address muscle imbalances
Principles of SMT

- 3 Keys
  - Posture: Maintained in foot, back & neck
  - Breathing: Diaphragmatic breathing
  - Control of COG & Eccentric movement
- Progressively challenge systems controlling balance

SMT Progression: CHALLENGE

- Tactile: support
- Visual: eyes closed
- Vestibular: rotate head
- Cognitive: mental tasks
- Exteroceptive: tape
- Speed: slow/fast
- Tissue Tolerance: volume, intensity, duration

Sensorimotor Training Progression: STAGES

- Static
  - Maintain COG with weight shift or perturbation on different BOS
- Dynamic
  - Add arm or leg movement on stable pelvis
- Functional
  - Add whole-body movements
1. Static
   a. Maintain balance on progressively unstable surfaces (Stability Trainers & Balance Boards)
   b. Progress by shifting weight, perturbations, closing eyes, adding head movements
   c. Progress to unilateral stance

Progress BASE OF SUPPORT:

- Stability Trainer
  - Green → Blue → Black
- Rocker Board
- Wobble Board
- Static Phase

Progress CENTER of GRAVITY: Weight Shifts

- Anterior: Lumbar PVM, G.Max, Hams, Gastroc
  - Posterior: Abs, Iliopsoas, Quads, Tibialis
  - Lateral: Hip adductors, Ankle invertors
  - Medial: Hip abductors, Ankle evertors

2. Dynamic
   - Add arm & leg movements while balancing on progressively unstable surfaces.
   - Use exercise bands, FlexBars, or Soft Weights.
   - Upper Extremity Exercise, Lower extremity exercise, Add Stabilization, Add Oscillation, Add Impuse
3. **Functional**: Perform functional movements (squat, lunge, step, push, pull, etc) on progressively unstable surfaces.
   - Incorporate functional movements on unstable surfaces

SMT Prescription:

- **FREQUENCY**: perform daily
- **INTENSITY**: less resistance, higher repetitions
- **DURATION**: 6 weeks for neural adaptation
- **QUALITY**: Control eccentric movements

Stabilization Training:

- **Advantages**
  - Activates muscles subconsciously
  - Variety of exercises and tools
- **Disadvantages**
  - Fall potential
  - Fatigue & compensations

Balance Training Precautions:

- ↓ Balance : guard patient
- Avoid fatigue & compensation
- Use support as needed
- Non-slip surface
Key Points

- Functional stability is a result of both local and global stabilization
- The Sensorimotor system controls functional stability
- Neuromuscular reflexive activation is more important than “strength”
- Sensorimotor training is a scientifically-based progression for stabilization training
- Used for injury rehab and prevention

Coding & Reimbursement

- **97110** Therapeutic exercise, one or more areas, each 15 min. Therapeutic exercises to develop strength and endurance, range of motion and flexibility.
- **97112** Neuromuscular Re-education, one or more areas, each 15 min. Neuromuscular re-education of movement, balance, coordination, kinesthetic sense, posture, and proprioception (such as stabilization or balance training)
- **97530** Therapeutic Activities, direct hands-on, each 15 minutes. Use of dynamic activities to improve functional performance with direct contact by the provider.

Therapeutic exercise (97110), Neuromuscular Re-education (97112), and therapeutic activities (97530) all require direct one-on-one provision of service according to Medicare guidelines.

  - Therapeutic Exercise (97110) includes activities related to strengthening, endurance training, range of motion, and flexibility.
  - Therapeutic Activities (97530) utilize dynamic activities to improve functional performance; these are also referred to as the "-ing" codes, for example, "lifting," "pulling," "pushing," "running," and "jumping."
• There is no specific CPT code for home exercise instruction*
  
  o Code for the time spent in educating the patient in a home exercise program for:
    ▪ strengthening & stretching activities : 97110
    ▪ balance activities : 97112
    ▪ functional activities : 97530
  
  o Remember that these codes are subject to the 'time' rule.