Proprioceptive Training for the Lower Extremity

Presented By:
Manuel C. Sanchez, PT, MPT, ATC, LAT

OVERVIEW

- Objectives
- Definitions
- Anatomy & Physiology of Proprioception
- Neuromuscular Components of Proprioception
- Progressions for Proprioception Exercises
- Female Considerations for Proprioceptive Training
- Specific Proprioceptive Exercise
- Conclusion
- References

OBJECTIVES

- To recall the anatomy and physiology of proprioception in order to formulate and implement an appropriate and effective proprioceptive exercise program.
- To attain the knowledge that after an injury proprioception becomes disrupted and is crucial to restore in order to prevent re-injury and maximize function.

Definitions of Proprioception & Associated Functions

- Proprioceptors-Sensory receptors responsible for deep sensations, found in muscles, tendons, ligaments, joints and fascia
- Proprioception-Afferent information including joint position sense, kinesthesia, and sensation of resistance
- Joint Position Sense-The ability to recognize joint position in space
- Kinesthesia-The ability to appreciate and recognize joint movement or motion
- Sensation of Resistance-The ability to appreciate and recognize force generated within a joint
- Neuromuscular Control-Appropriate efferent responses to afferent proprioceptive input

Andrews et al

Anatomy & Physiology of Proprioception

Neural Input into the Central Nervous System is provided by:

- Peripheral mechanoreceptors
- Visual System
- Vestibular System

3 Classes of Peripheral Mechanoreceptors

- Muscle receptors-Primarily consist of muscle spindles and Golgi tendon organs.
- Articular (Joint) receptors
- Cutaneous (Skin) receptors

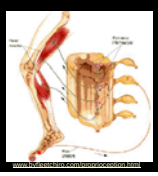
DeLee & Drez

Anatomy & Physiology of Proprioception

Afferent input from these receptors is integrated by the Central Nervous System generating a motor response.

3 Levels of Motor Control Responses:

Spinal Reflexes
Cognitive Programming
Brainstem Activity



Anatomy & Physiology of Proprioception

- Spinal Reflexes-Activation of reflex muscular stabilization that transpires when a joint is loaded.
- Cognitive Programming-Voluntary motor instincts that are kept internally therefore no need for conscious recall.
- Brainstem Activity-Coordination of movements that result in balance and posture.

Wells, L.

Anatomy & Physiology of Proprioception

- Proprioception can be conscious or subconscious
  - Conscious (Voluntary)
  - Subconscious (Reflex Initiated)
- Proprioception encompasses static and dynamic aspects of position sense
  - Static Position Sense
  - Dynamic Position Sense

Nyland, J.

Neuromuscular Rehabilitation

- Adaptations in motor response occur based on information received and processed by the proprioceptive system before or during a potentially harmful stimulus
- Proprioceptive exercises stimulate the nervous system promoting muscle responses that encourage neuromuscular control
- After a lower extremity injury, there is a loss of muscular co-contractions due to the loss of the neuromuscular feedback mechanism
- It's essential to not only retrain muscles but also work on proprioception

Lephart et al

Neuromuscular Rehabilitation

Program Should Include:

- Balance exercises
- Dynamic joint stability exercises
- Plyometric exercises
- Agility drills
- Sport-specific exercises

Andrews et al

Neuromuscular Rehabilitation

Goals of Proprioceptive Retraining:

- Increase the frequency of muscle unit stimulation
- Increase the synchronicity of motor unit firing
- Increase proprioceptive and kinesthetic awareness

Lephart et al

Neuromuscular Rehabilitation

Sequence of Progression with the Stages of Motor Control:

- Mobility-Open Chain
  ROM/Strength; Proximal fixed; Distal free
- Stability-Closed Chain
  Co-contraction; Distal fixed; Proximal hold
- Controlled mobility-Closed Chain
  Weight shift; Move on fixed point
- Static Dynamic-Closed with open chain
  Weight shift; fixed with free points
- Skill-Functional Activity

Braden, H.

Neuromuscular Rehabilitation

Additional Concepts to Consider:

- High Repetition-Vital for cognitive programming of motor patterns
- Feedback-Required to recognize SUCCESSFUL completion of a task
- Function Specific-Correct type of movement is required in order to recruit the correct ventral horn output
- Challenge to the NM System-Decreased stability, increased speed and number of components

Wells, L.

Proprioceptive Progression

- Weight Shifts-knees unlocked, start with going forward and back progressing to lateral, smooth transitions. Hold 10 secs
- Balance Exercises-focus on awareness of body position, achieved by maintaining COG over BOS
  Progress by changing visual, vestibular and somatosensory parameters
  Increased challenge by utilizing medicine ball and rebounder

Nyland, J.

Proprioceptive Progression

- Cone Walking-Emphasize proper gait sequence of shifting weight from heel to toe, tightening the quads on heel strike, while balancing on injured leg. Can perform forward and laterally
- Sports Cord-Always begin with forward and backward walking, add lateral when appropriate. Progress to step outs with hold versus sports cord resistance

Nyland, J.

Proprioceptive Progression

- Plyometrics-Quick, powerful movements involving a pre-stretch of the muscle, which activates the stretch shorten cycle.
- Goal of plyometrics is to decrease the time required between the expiring eccentric contraction and the start of the concentric contraction, Amortization

Chu, D.A.

Proprioceptive Progression

Precautions and Considerations:

- Landing surfaces should be soft
- Quality of movement is imperative
- Training should be done without fatigue
- React to the ground quickly for all movements, do not absorb forces but redirect them

Chu, D.A.

Proprioceptive Progression

6 Classifications of Lower Extremity Plyometric Exercises:

1. Jumps in place-Two foot landing
2. Standing jumps-Maximal effort
3. Bounding-Series of movements where athlete lands on alternating feet
4. Multiple hops and jumps-Focus is on speed and agility, not maximal effort
5. Box jumps
6. Depth jumps

Chu, D.A. and Nyland, J.

Female Athlete

8 Factors to Consider when Designing Rehabilitation Programs for Females:

1. Exhibit a wider pelvis and increased genu valgu
2. Recruit the quadriceps to stabilize the knee
3. Generate muscular force more slowly than males
4. When performing jumps, females lose hip control upon landing
5. Tend to have less developed thigh musculature
6. Exhibit greater genu recurvatum and increased knee laxity
7. Exhibit less effective dynamic stabilization
8. Posses decreased muscular endurance in comparison to males

Wilk et al

Female Athlete

Components to Incorporate into a Female Rehabilitation Program

- Dynamic control of the valgus moment at the knee
- Retrain the NM pattern to utilize the hamstrings
- Train for fast speeds and reaction timing
- Train hip and trunk control
- Train hip muscles to assist in stabilization
- Train athlete to control knee extension
- Enhance NM control and protective pattern reflexes
- Enhance muscular endurance

Wilk et al

Proprioceptive Training Exercises

Conclusion

Incorporating proprioceptive training into a comprehensive rehabilitation program is crucial. Understanding the anatomy and physiology of proprioception allows for the development and implementation of an effective training program, thus returning the athlete to their maximum function at a decreased risk for re-injury.

References:

1) Andrews, J.R., Harrelson, G.L., Wilk, K.E.,, (2004). *Physical Rehabilitation of the Injured Athlete.* Saunders, Philadelphia, PA, Pgs. 189-212
2) Braden, H., (2006). Motor Control and Motor Learning Notes. UTHSCSA; San Antonio, Texas
3) Brewer, P., (2006). Anatomy I Notes. UTHSCSA; San Antonio, TX
4) Chu, D.A., (1992). *Jumping into Plyometrics,* Human Kinetics, Champaign, IL
5) DeLee, J.C., Drez, D., (2003). *Orthopaedic Sports Medicine, Principles and Practice.* Saunders, Philadelphia, PA, Pgs. 330-334
6) Dutton, M., (2004). *Orthopaedic Examination, Evaluation & Intervention.* McGraw-Hill, New York, Pgs. 55-57, 306-307
7) Haines, D.E., (2002). *Fundamental Neuroscience.* Churchill Livingstone, Philadelphia, PA, Pgs. 256-272
8) Lephart, S.M., Irrgang, J.J., Safran, M.R., Fu, F.H. The role of proprioception in the management and rehabilitation of athletic injuries. *American Journal of Sports Medicine,* Vol. 25; Pgs. 130-137
9) Levangie, P.K., Norkin, C.C., (2005). *Joint Structure & Function, A Comprehensive Analysis.* F.A. Davis Company, Philadelphia, PA, Pgs. 133-134
10) Malone, T.R., Hardaker, W.T., Garrett, W.E., Feagin, J.A., Bassett, F.H., (1999). Relationship of Sex to Anterior Cruciate Ligament Injuries in Intercollegiate Basketball Players. *Journal of Southern Orthopaedic Association,* Vol. 2; Pgs. 36-39
11) Nyland, J., (2006). *Clinical Decisions in Therapeutic Exercise, Planning and Implementation.* Pearson Prentice Hall, Upper Saddle River, NJ, Pgs. 273- 301
12) Wells, L., (2005). UTHSCSA 32nd Symposium on Sports Medicine. UTHSCSA; San Antonio, Texas
13) Wilk, K.E., Andrews, J.R., Clancy, W., (1999). Rehabilitation after Anterior Cruciate Ligament Reconstruction in the Female Athlete. *Journal of Athletic Training,* Vol. 34(2); Pgs. 177-193