Proprioceptive Training for the Lower Extremity

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OVERVIEW

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- Neuromuscular Components of Proprioception
- Progressions for Proprioception Exercises
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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.

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

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.

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

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.
Neuromuscular Rehabilitation

Program Should Include:

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

Andrews et al.

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.

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

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

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
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.

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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

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
Female Athlete

8 Factors to Consider when Designing Rehabilitation Programs for Females:

1. Exhibit a wider pelvis and increased genu valgus.
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. Possess decreased muscular endurance in comparison to males.

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.

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: