Proprioception is the special variation of the sense of touch that encompasses the sensation of joint movement, described as kinesthesia, and joint position (Lephart et al., 1997). It is the sense that contributes afferent information to the central nervous system (CNS) and allows for the precision of movements and muscular reflexes, all providing for dynamic joint stability to prevent excessive strain on the joints and muscles (Borsa et al., 1997; Lephart et al., 1997).

The proprioception phase of rehabilitation is critical following sports injury. It must be introduced in a timely fashion with enough intensity to stress ligaments, muscles, and tendons, but gently enough to prevent reinjury.

The article is intended to help you apply the principles of proprioceptive rehabilitation to improve neuromuscular control in athletes with lower extremity injuries.

### Key Points

- Extremity function depends more on the input received via proprioception than on the amount of strength available during the activity.
- When joints are injured, they lose their ability to correctly gauge the stresses imposed on them. This is the major factor predisposing the athlete to reinjury.
- Proprioception exercises for the lower extremity should progress from balance to balance & reach to excursion movements.

Athletic trainers and therapists are called upon to return injured athletes to functional patterns of movement in their sports and everyday activities. Extremity function has been shown to be more dependent on the input received via proprioception than the amount of strength available during activities (Borsa et al., 1997). When joints are injured or immobilized, they lose their ability to correctly gauge and react to stresses imposed upon them. This loss of neuromuscular control is probably the major factor predisposing the athlete to re-injury.

The rehabilitation program must ensure that the different levels of motor control are retrained with exercises that include functional movement patterns common for that athlete's sport.

Three levels of motor control need to be challenged when retraining the afferent pathways involved in proprioceptive function: spinal, brainstem, and cognitive awareness (Lephart et al., 1997; Prentice, 1994).

The spinal level facilitates the use of reflexes and quick responses to joint motion. Short, quick movements imposed on the body during rehabilitation would provoke the reflexes responsible for dynamic joint stability.

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The second level of control is located at the brainstem. Information from mechanoreceptors, vestibular centers, and visual input initiate neuromuscular control at this level. Balancing activities with the eyes open or closed are useful for improving neuromuscular control at the brainstem level.

The third level of neuromuscular control is found in the cognitive awareness centers of the brain associated with joint and body position. These centers determine fine-tuning of movements, muscle memory, and cortical pathways used during the control of motion. The use of repetition and practice in rehabilitation will stimulate these proprioception centers.

Closed kinetic chain (CKC) exercises are useful in helping to redevelop lower extremity neuromuscular control following injury. A CKC exercise is described as one in which the distal segment of the limb is in contact with a surface or is fixed and stabilized.

Lower extremity CKC exercises involve the foot being in contact with the ground. These exercises help improve proprioception through changes in joint position and movement patterns, axial compression through the joints, and muscular co-contraction occurring to maintain stabilization (Davies, 1995).

Multiplanar motions in conjunction with varying repetitions and time periods provide an efficient method of enhancing neuromuscular control of the lower extremity. Multiplanar motions occur when movements in the frontal, sagittal, and transverse planes occur simultaneously.

CKC exercises are well suited to provide a combination of motion in all three planes. Improvements in muscle strength and girth are commonly observed due to the varying isometric, concentric, and eccentric muscular contractions required to maintain balance during CKC exercises (Bunton et al., 1993).

Improved neuromuscular function of the lower extremity should be enhanced through CKC exercise. Function in the CKC has been described as a complex integration of joints moving, proprioceptors facilitating, and muscles reacting all at the same time in multiple planes of motion (Gray, 1995). The rehabilitation program should create an environment that is varied yet specialized enough to address the challenges associated with the athlete's sport.

The rehabilitation environment can be manipulated by changing the planes, joints, ranges of motion, loads applied, positions, control of motion, speed of motion, feedback offered, and the duration of motions. Athletic trainers and therapists can determine where, when, and how much motion occurs during rehabilitation by varying these factors.

Only appropriate amounts of motion should be allowed as determined by the stage of healing of damaged tissues. A system of progression should be implemented as with any rehabilitation program.

The following exercises are suggested based on their ability to enhance overall lower extremity proprioception for many sport activities. They should be modified to match the functional requirements of the athlete's particular sport.