S KILL PERFORMANCE IN the sport of soccer results in tremendous shear forces being transmitted through the tibiofemoral articulation of the knee. These forces are directly related to the inherent demands of the game that include repetitive single-leg eccentric control and dynamic stabilization of the plant leg during the kicking motion, full-speed cutting maneuvers, and unpredictable spontaneous footwork patterns while dribbling the ball or avoiding a tackle. These factors, in addition to the contact nature of the sport, require soccer athletes to have full proprioceptive input from the sensory afferents so that appropriate neuromuscular control can be elicited for both skill performance and injury avoidance. This is especially important in soccer because most of the skills are executed with dynamic stabilization on a single leg while performing the desired skill with the contralateral leg. As a result, it is imperative that a major component of a postoperative anterior cruciate ligament (ACL) rehabilitation program for soccer players include reestablishing kinesthetic feedback, proprioceptive mechanisms, and neuromuscular control of the entire lower extremity so that optimal dynamic stability can be achieved during skill performance.

The Concept of Perturbation Training

Perturbation training was first described by Wilk et al. as an essential component in the postoperative ACL rehabilitation of female athletes. During this form of training, a postural disturbance is imposed on the affected extremity, eliciting a protective motor response in the surrounding musculature of the knee. The goal is to actively control these destabilizing forces, which when incorporated into a rehabilitation regime will improve the protective reflexes, enhance neuromuscular control, and facilitate improved muscle-reaction times. Perturbation training has also been theorized to allow ACL-deficient athletes to return to high-level sport activities and reduce episodes of functional instability. It has also been suggested that applying perturbation techniques during skill performance might elicit a more functional neuromuscular-control motor response that has a greater carryover effect to game situations. The importance of this concept becomes magnified when it is considered in conjunction with the theory that ACL reconstruction might restore mechanical stability, but the restoration of functional stability might not be guaranteed.

Perturbation and agility training should be used as an adjunct to the typical postoperative ACL-rehabilitative protocol for soccer athletes. Once a player exhibits appropriate levels of neuromuscular control of the knee, perturbation training is initiated in the form of skill performance (volleying, kicking, or trapping) while attempting to control destabilizing forces. These forces are usually applied in the form of balancing or landing on an unstable surface or some form of external resistance (Figures 1 and 2) that results in an unexpected perturbation of the support surface. Because external forces are applied in an effort to challenge an athlete, the appropriate level of neuromuscular control needed for him or her to begin such exercise routines should be determined on an individual basis, using the ability to balance unilaterally on the affected limb in a safe manner for a time at least as long as that of the intended perturbation exercise. The difficulty of the exercise is enhanced...
by increasing the amount of momentum generated by the body on landing (longer final-approach step) or by incorporating a multiplanar component (lateral, diagonal, or rotational steps). Any of these alterations will result in an increase in the destabilizing force that the affected limb must learn to control.

The Role of Agility Training

Agility training should be viewed as a natural progression that necessitates specific attention during the rehabilitation of any athlete. Agility demands uncompromised neuromuscular control and kinesthetic awareness of the knee with the addition of the application of functional speeds. This results in a greater degree of external momentum, which the affected joint must learn how to control. It has been reported that functional activities such as cutting can elicit up to 161% maximum voluntary contraction of the quadriceps, thus indicating that strengthening programs alone might not adequately prepare the knee for the functional forces that will be encountered during competition.

Agility training in the clinical setting can be addressed by using a commercially available “agility ladder.” The most beneficial use of the ladder for soccer players is in the form of fast-footwork activities, which stress a quick return of the feet to the ground, and an avoidance of high-knee-type activities (Figure 3). Once the basic footwork patterns have been mastered, a progression to more complex multiplanar patterns is appropriate, culminating in the integration of a soccer-specific skill to the activity (Figure 4).

An added benefit to using agility techniques is the ability to have an additional method to assess the player’s dynamic stabilization capability during functional activity in a more dynamic environment. Some studies have indicated that isokinetic strength testing and functional hop testing might be