Neuromotor Coordination and the Prevention of Running Injuries

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For more than 30 years, researchers have been trying to identify specific risk factors that can predetermine whether or not a runner is likely to be injured. With an annual injury rate exceeding 50%, runners could save them selves a lot of time and frustration if they could identify and correct specific risk factors predisposing them to injury. To date, researchers have focused on arch height, flexibility, strength, and bony alignment (i.e, being bow legged). Unfortunately, while a few anatomical factors have correlated slightly with future injury, the connections have been weak and interventions have produced relatively poor outcomes. The classic example is stretching: while tight muscles are more likely to be injured with intense workouts (1), stretching has rarely shown to influence injury rates.

Recently there have been a few interesting studies suggesting that correcting impaired neuromotor coordination may play an important role in injury prevention (2,3). Because coordinated muscles are capable of smoothly decelerating joint motions even if the muscles themselves are relatively weak, it is very important to identify and correct problems affecting muscular coordination. The most common cause of impaired neuromotor coordination is prior injury. To protect you from further injury, the central nervous system essentially rewires itself by creating an alternate pattern of muscle recruitment to avoid stressing the damaged soft tissues. Referred to as a motor engram, the altered pattern of muscle recruitment persists long after the injury has healed. The perfect example of a faulty motor engram occurs following an ankle sprain. Laboratory evaluation of muscle activity confirms that immediately following an ankle sprain, the muscles on the outside of the leg pretense with greater force just before your foot hits the ground (4). Pretensing the outer leg muscles protects the damaged ligament by keeping the rearfoot in a stable position during initial ground contact.

Although usually helpful, all too often the motor engrams created are damaging. For example, while increased activity in the outer leg muscles following an ankle sprain is protective, ankle sprains have also been shown to impair recruitment of the hip muscles on the side of the sprain. While the exact mechanism responsible for producing inhibition is unclear, the decreased muscle activation in the hip results in impaired stabilization of the entire lower extremity. The resultant hip weakness frequently produces a gait pattern in which the knee is allowed to twist in excessively. The inward collapse of the knee is associated with the development of a wide range of running injuries.

In one of the more interesting motor engrams I've seen, an Olympic Trials Marathon runner compensated for an outer hamstring injury by switching from a heel to a forefoot strike pattern on the injured side. She also began running with the injured leg turned out almost 35°. Until her uneven shoe wear was pointed out, the runner had no idea that she was striking on her forefoot on one side and her heel on the other. This specific motor engram

developed because the forefoot contact point reduced her stride length on the injured side. The reduced stride length lessens strain on the hamstrings because these muscles decelerate forward motion of the swing phase leg: the shorter the stride, the less the hamstring strain. The toe-out gait pattern also reduced strain on the hamstring muscles because it allowed her to use her hip abductors to decelerate forward motion of the swinging leg. Long after the hamstring healed, she continued to run with this faulty running style.

To help identify faulty motor engrams, researchers have developed a series of functional tests to evaluate your ability to recruit muscles in a smooth and coordinated manner. The most promising functional test is the Y-balance test (Fig. 1). This test is performed by placing a tape measure on the floor, angled 45° backwards away from your weight-bearing foot. While balancing on one leg, reach back with your toe and touch the farthest point on the ruler you can without losing your balance. Repeat this measurement on both sides and compare the differences. According to a recent study, runners with reach differences greater than four centimeters are 2.5 times more likely to sustain an injury (2).

The best way to improve your reach distance is to strengthen your knees and hips with the single-leg cone-touch exercise (Fig. 2). Once you feel stable, you can perform the cone-touches while standing on an unstable surface, such as The AirEx Balance Pad. An alternate way to improve your reach distance is to perform lunges on a Dynadisc (Fig. 3). To perform this exercise, place the Dynadisc close to you and do a small range of motion lunge.

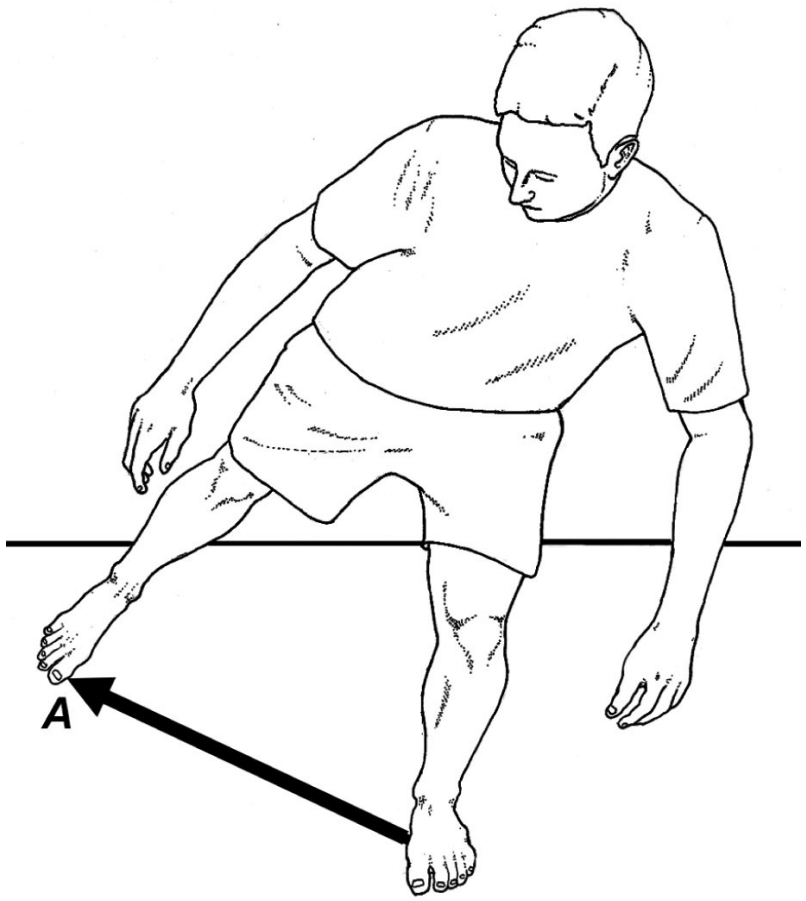
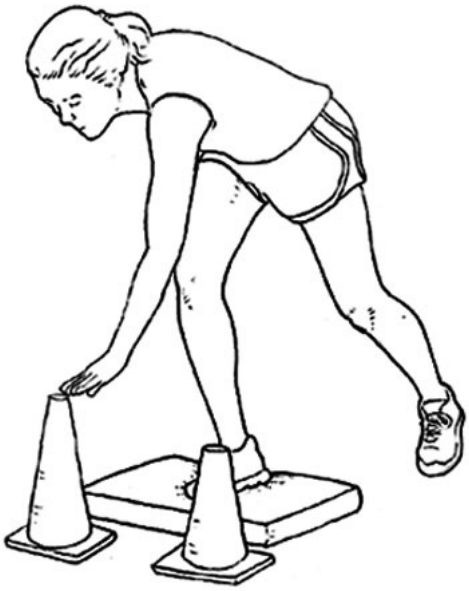


Fig. 1. **The Y-balance test.** Place a cloth tape measure on the floor angled 45° back. While standing on one foot, reach back as far as you can without touching the ground. Note the farthest distance you can reach on the tape measure without losing balance and compare right and left sides. You may need a friend to spot the contact point on the tape measure or you can place a small box on top of the tape and push it back while maintaining balance. Redrawn from Hertel (2).

Fig. 2. Single leg cone touch. While standing on one leg on an unstable surface (such as the AirEx Balance Pad), pivot forward at the hip so you touch the top of a cone placed in front of you. Immediately jump up and repeat the cone-touch on a neighboring cone.



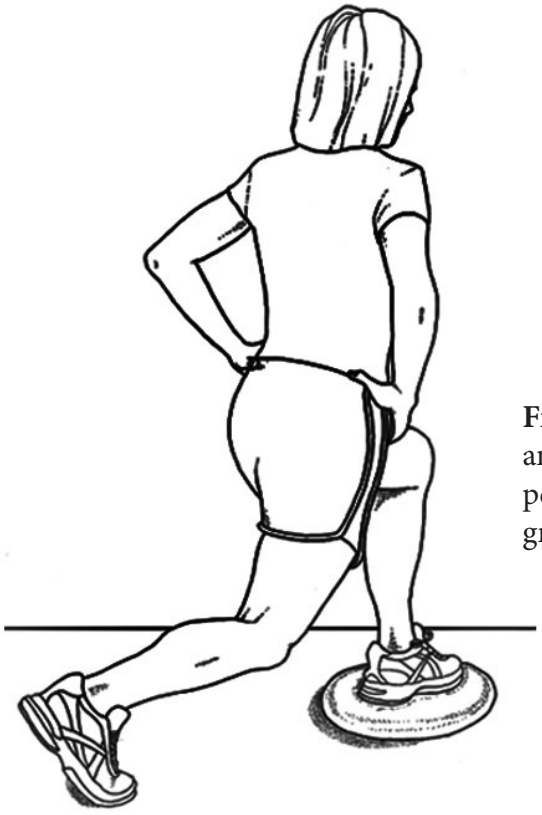


Fig. 3. Dynadisc lunge. A conventional lunge can be performed on an unstable surface to enhance coordination. Be very careful while performing this exercise. At first, make sure you have something to grab onto, should you lose your balance.

Until you are confident in your ability to balance, Dynadisc lunges should only be performed while standing near a wall or some stable structure that you can quickly take hold of if necessary. When you initially perform this exercise, even a slight problem with coordination will cause your knee and hip to shift rapidly back and forth. Because the supporting disk is unstable, you quickly learn to tense your hip abductors and rotators in order to stabilize yourself. Over time, this movement pattern becomes more natural and the improved muscle function allows you to run with a more stable running form. Some great research suggests that balancing on unstable surfaces allows you to rewire your movements without conscious thought, and the reflexive corrections are more permanently engrained.

To correct faulty movement patterns while running, in addition to balance and agility training, runners need to incorporate specific gait retraining techniques to permanently correct faulty motor engrams. Although it may sound complicated, gait retraining can be as simple as running on a treadmill positioned in front of a mirror while deliberately modifying a faulty movement pattern. The most common glitch in running form that needs to be corrected is excessive inward twisting of the knees. While running, focus on keeping your knees moving straight back and forth with no inward rotation. By consciously focusing on improving a specific movement pattern, you can teach your muscles how to fire properly and the movement pattern is eventually memorized by your nervous system. In a thorough review of the literature evaluating the best ways to prevent knee injuries in athletes, the respected researcher Tim Hewett notes that injury prevention is best accomplished by coupling balance exercises with agility drills, strength training, and visual feedback (5). Dr. Hewett emphasizes that an important way to reduce the potential for injury is by recruiting the help of a knowledgeable friend who can inform you when your form begins to falter.

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