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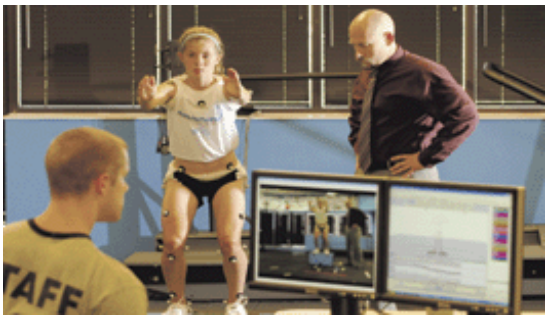
Leveling the playing field

By Annie Hayashi

How neuromuscular training gets girls back in the game

Sophia was a very talented volleyball and basketball player. By the time she was age 16, college scouts were already recruiting her.

Then she played the volleyball game that ended all games. She went up for a spike, hit the ball just right, and landed hard on her left leg. She heard the "pop" as her left anterior cruciate ligament (ACL) ruptured. Her scholarship prospects were gone as quickly as her ACL was torn.



Neuromuscular training, including biofeedback and motion analysis techniques, may help reduce the incidence of ACL injuries among female athletes. Photo courtesy of Timothy E. Hewett, PhD, and the Cincinnati Children's Hospital.

Is less flexion in the female knee to blame?

The orthopaedic literature indicates that female athletes tear their ACLs at a rate 4 to 6 times greater than their male counterparts. Not only is the tear rate higher, but once the ACL is repaired, female athletes have a higher risk for osteoarthritis 20 years later.

Many orthopaedic surgeons attribute this tendency to how female athletes "land," maintaining that women flex their knees less than men do when landing from a jump, as happened in Sophia's case.

Timothy E. Hewett, PhD, has spent much of his career exploring this phenomenon—examining hours of videotapes of ACL injuries; watching young male and female athletes in games that require cutting, pivoting, and landing; and conducting prospective studies to understand why female athletes have a higher rate of ACL injuries and what can be done to prevent them from occurring.

He thinks that low flexion (approximately 0 to 20 flexion) is part of the mechanism of injury in female athletes, but he necessarily have less flexion than men. In an article published in the March 2006 issue of the *American Journal of Sports Medicine,* Hewett identified the following factors that contribute to higher rates of ACL injuries for females:

- Valgus positioning of the lower extremity
- Relative extension with unbalanced weight distribution
- Plantar surface of the foot being fixed in position, away from the body's center of mass

Athletes can be trained to increase dynamic joint stability using perturbation training on an unstable surface. Photo courtesy of Timothy E. Hewett, PhD, and the Cincinnati Children's Hospital.

Maturation and neuromuscular imbalances

Prior to puberty, according to Dr. Hewett, girls and boys move and land in similar ways and have a similar risk of ACL injuries. At puberty, the sexes begin to develop distinct differences.

Timothy E. Hewett, PhD

Soon after puberty, a boy experiences a "neuromuscular growth spurt." His power, strength, and coordination continue to increase with his chronologic age. "If I am measuring full body power, boys are getting disproportionately more powerful," explains Dr. Hewett. "They are developing more 'horse power.' Even though the boy is heavier and has more mass, he is able to displace that mass higher in the air."

As a girl grows, she also becomes more powerful. But unlike her male counterpart, she becomes proportionally more powerful and does not experience that same "neuromuscular growth spurt." Unless she makes the appropriate neuromuscular adaptations to dissipate the forces and control the additional mass as her body matures, the forces and mass will be transferred to the joints and the ligaments.

"Girls demonstrate decreased knee flexor torques, greater lower extremity valgus motion, and greater maximum valgus angle between each successive stage of maturation compared with boys," according to a study Dr. Hewett published in the December 2004 issue of *The Journal of Bone and Joint Surgery.*

Body compensates for changes

A female athlete develops various neuromuscular imbalances in response to the changes that occur during maturation.

Dr. Hewett categorizes those imbalances into the following four primary areas:

- *Ligament dominance*: Female athletes become "ligament dominant" as a result of using their knees as "ball-and-socket" joints. When the knee is used as a "hinge," the muscles of the lower extremities dissipate the force as the knee lands. If the knee goes into a valgus position, the muscles are not able to dissipate the force well in that direction. Instead, the force is transferred to the ligament rather than to the muscle.
- *Quadriceps dominance*: Female athletes tend to control the force of a landing or a cutting maneuver by "turning on the quadriceps." Though the quadriceps does dissipate the force, its single tendon construction doesn't control varus/valgus motion well. When the athlete flexes the quadriceps, she pulls the tibia forward—putting greater stress on the ACL.
- *Leg dominance*: Female athletes tend to favor one leg over the other. The dominant leg gets stronger and develops better muscle recruitment patterns and more torque and force—putting the contralateral leg at risk.

Longitudinal studies, conducted by Dr. Hewett of movement patterns, showed that side-to-side differences in motion and force were found to be some of the best predictors of future ACL injury risks.

- *Trunk (core) stability*: At least 60 percent of a person's entire body weight is in the trunk. Because girls and women have less trunk stability than males, female athletes put more force and torque on their knees—putting them at higher risk for ACL injuries.

Young female athletes practice a good "athletic ready" position, with their chests aligned over their knees and the knees aligned over the balls of the feet, where their weight is balanced. Photos courtesy of Timothy E. Hewett, PhD and the Cincinnati Children's Hospital.

"DNA training"

To help reduce the risk of an ACL injury, Dr. Hewett and his colleagues developed "dynamic neuromuscular analysis" (DNA) training techniques for female athletes. DNA training is a four-part program that uses biomechanical and feedback techniques, plyometrics, core stability training, and strength training to address the neuromuscular imbalances previously identified.

Click below to see demonstrations of neuromuscular training:

Bounding in place

Bosu 2 feet ballcatch

Bosu drop xploder

Biomechanical training teaches girls to use the knee as a "hinge joint" and to "tighten up those springs" rather than using it as a loose "ball-and-socket." This helps address the issue of ligament dominance, which results from knee abduction.

Quadriceps dominance is related to low flexion, so plyometrics is used to increase hamstring-to-quadriceps recruitment and strength. Deep flexion drills help increase the power and strength of the hamstrings, forcing relative hamstring-to-quadriceps recruitment.

To offset the dominant use of a single leg, Dr. Hewett recommends balance training. "We start proximally," he explains, "with balance training on a wobble board, and with the girls kneeling. We focus on the hips and the trunk, and then move away distally to the foot. We also teach single-leg balance techniques where the legs are as symmetrical as possible. When athletes land, they bring the force across both legs and down both sides."

Core stability training has three components—proprioceptive, strength, and stability—that are incorporated into the training program to address core neuromuscular imbalances.

For the training to be effective with younger athletes who need it most, it should be fast-paced, oriented to the sport the girl plays, and provide immediate feedback to her on posture, position, and balance. Until an athlete develops a

proprioceptive sense of her placement—a sense of where her core is in relationship to the other parts of her body, she will need the trainer to give her cues and coaching.

Out of the game

Sophia, who hadn't had any neuromuscular training, had surgery to repair her torn ACL. Thanks to her orthopaedic surgeon and physical therapist, she is making excellent progress. But with diminished prospects for an athletic scholarship, she is focusing on academics for her future.

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