Women's Movement –
Female Athletes are Particularly Prone to ACL Injury

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A 15-year-old female soccer player streaks down the field following a long aerial pass from a teammate. Just as she is about to intercept the pass, a player from the opposing team heads the ball away. She plants her foot and begins to make a hard cut to run down the redirected pass. As she makes the cut, she feels a painful "pop" in her knee, which buckles, and she collapses to the ground.

The most important structure in her knee, the anterior cruciate ligament (ACL), has just ruptured, ending her soccer season and threatening her ability to play competitive sports in the future.

More Players, More Problems

As the number of female athletes has increased over the past three decades, coaches, trainers, therapists, and physicians have noted an alarming trend. Certain injuries occur at a much higher rate among female athletes. The most devastating injury sustained at a higher rate by girls is the ACL rupture.

A ligament is a band of tissue that tightly connects two bones together at a joint. When a ligament ruptures or tears, increased motion occurs between the two bones and the joint loosens. The loose or unstable joint can buckle during running, jumping, and cutting maneuvers.

The torn ligament often results in an inability to compete in sports in the short term and premature wearing out of the joint or early arthritis with time. The ACL connects the femur, or thighbone, to the tibia, or shinbone, in the center of the knee joint. It is arguably the most important ligament in the body.

Studies conducted by the National Collegiate Athletic Association over the past 15 years document a threefold higher rate of ACL injuries in female soccer and basketball players than in males in similar sports. Similar studies show that high school female athletes tear the ACL ligament eight times more often than high school male athletes.

Injury Mechanism

Review of game videos over the past 15 years has shown that the typical female ACL injury occurs in the absence of player-to-player contact. The classic noncontact ACL tear results from an awkward landing, rapid deceleration, pivoting, or cutting maneuver performed in response to a sudden change in the direction of play. The hip internally rotates, the knee collapses toward the midline, and the ACL ligament tears.

Risk Factors

Research conducted by the orthopaedic surgery, physical therapy, and athletic training communities has identified several potential reasons for the higher rate of ACL tears among female athletes.

The amount of traction generated by the playing surface and a player's shoes definitely affects the rate of ACL injury. Artificial turf creates a higher degree of friction between the player's foot and the playing surface, increasing the number of knee injuries. However, increased playing surface and shoe friction affect male and female athletes equally and does not explain the difference in the rate of ACL tears.

There are obvious structural differences between males and females. The thickness of the ACL and the space within the knee for the ligament are both, on average, less in women. Despite these differences, no study to date has documented a difference in the rate of knee ligament injury based on these structural differences alone.

Recent research has shown some evidence that hormonal differences between males and females may contribute in part to the higher rate of ACL tears in female athletes. High levels of estrogen can weaken the structural properties of ligaments. However, the majority of this research involves animal models and has not been validated by human studies.

In contrast to playing surface friction, structural differences, and hormonal influences, numerous studies have shown that dynamic knee control plays a major role in the higher rate of ACL tears in female athletes.

The Developing Muscles

Knee stability is produced by static and dynamic structures. Static contributors to knee stability include bony fit, ligaments (particularly the ACL), and the joint capsule. All muscle–tendon units crossing a particular joint provide dynamic joint stability.

The key muscles in dynamic knee stability include not only the hamstring and quadriceps but also the hip external rotators, abductors, and the abdominal muscles. If the dynamic knee stabilizers or muscles are weak, added force is placed across the static knee stabilizers, namely the ACL, during sports activities.

Research has shown that girls and boys have comparable strength and very good knee stability at a young age. When they go through the adolescent growth spurt or puberty, however, a dramatic change occurs in knee stability.

As teenage boys grow, testosterone levels rise, resulting in enhanced muscle strength and improvement in dynamic knee stability. Noncontact ACL tears are, therefore, very uncommon among young males. In contrast, as female athletes progress through the adolescent growth spurt, the lower extremity lengthens but there is a lack of muscle growth, resulting in a decrease in dynamic or muscular knee stability.

Strength and Positioning

Adolescent females, in general, demonstrate weaker core strength, which allows the pelvis to tilt forward and produces compensatory internal rotation of the hips that places the ACL at risk. Hip extensors, abductors, and external rotators (i.e., hamstrings, gluteal muscles, and short external rotators) are weaker in females. The combined core, hip, and hamstring muscle weakness places the thigh, knee joint, and leg in an internally rotated, “knock knee” position. This valgus, or “collapsed knee,” position allows for high rotational forces across the knee during activity, produces high sheer stress across the ACL, and results in noncontact ACL tears.

No Smooth Landing

In addition to poor positioning due to muscle weakness, the female athlete tends to jump and land in a more straight-legged, flat-footed position. Specifically, female athletes land with approximately 5 degrees less knee flexion, 9 degrees less hip flexion, and 9 degrees greater knee valgus than their male counterparts. Landing in this manner places the center of gravity behind the knee joint, induces strong forces in the quadriceps muscle, prevents the hamstrings muscles from optimally stabilizing the knee joint, and subjects the ACL to tremendous levels of stress during sporting activities.

Preventing Noncontact ACL Injuries

To decrease the alarming rate of ACL tears among female athletes, several injury-prevention programs have been developed. The Prevent Injury and Enhance Performance, or PEP, program is arguably the most successful. The PEP program is a 20-minute, focused warm-up program designed to replace conventional stretching exercises.

Improving dynamic knee control and knee alignment during jumping and cutting maneuvers is the primary focus of the PEP program. Core strength, hip musculature strength, and hamstring strength are all enhanced through a variety of sport-specific stretches and resistance exercises. On-field agility drills improve knee stability during explosive soccer moves such as jump landing and cutting.

In a study of more than 2,000 female high school soccer players, New Mexico Orthopaedics’ PEP program resulted in a decrease in the rate of noncontact ACL injuries by 88%. The sports medicine physicians and physical therapists of New Mexico Orthopaedics have introduced the PEP program to New Mexico through a series of instructional clinics presented to Albuquerque girls’ club soccer, high school soccer coaches, and athletic trainers. They are instructed on the program in detail, given the opportunity to practice the program, and become experts in ACL injury prevention so they can instruct their own players. Our physicians, therapists, and staff are committed to preventing ACL injuries in our community and will continue to conduct free PEP clinics on a regular basis.

Summary

With the growing number of female athletes, it is increasingly clear that certain injuries occur at a higher rate in the female athletic population. One of the more disabling injuries is the noncontact ACL rupture. Focused research incorporating epidemiology, video analysis, and biomechanics has identified a gender difference in knee joint stability as the primary factor resulting in the higher rate of noncontact ACL injuries among female athletes. Specific prevention programs, such as the PEP program, have evolved in response to this research and have dramatically decreased the rate of injury in the female athletic population.