Update on Anterior Cruciate Ligament Rupture and Care in the Female Athlete

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KEYWORDS

• ACL • Anterior cruciate ligament • ACL reconstruction • Anterolateral ligament • Anterolateral complex • Female athlete • ACL outcomes

KEY POINTS

- Anterior cruciate ligament (ACL) rupture rates in females are on the rise.
- ACL reconstruction must not be a one-size-fits-all approach but must be individualized to restore the native ACL anatomy and address any concomitant injury to secondary stabilizers.
- ACL rehabilitation programs should target hip, core, and trunk neuromuscular control; allow adequate time for graft ligamentization; and address the psychosocial needs of the athlete.
- Return-to-sports assessment requires a multipronged approach; no one test can determine return-to-sports readiness, and a battery of tests is required.
- A team approach involving the surgeon, athletic trainer, therapist, patient, family, and coach is paramount in achieving optimal outcomes after ACL reconstruction.

Despite advances in the surgical care of patients with anterior cruciate ligament (ACL) rupture over the last 30 years, prevention of the initial injury remains elusive, especially in athletes 14 to 19 years old. Beginning with Title IX and female athletic participation increasing 10-fold over the last 40 years, ACL tear rates in female athletes have continued to plague female athletes, with rates estimated at 2 to 8 times those experienced by male athletes.[1] This finding is most true in cutting sports with periods of rapid deceleration, such as soccer, with rates twice as high as men. In basketball, rates of female athlete ACL rupture is 3 to 4 times that of male athletes.[2] The cause of these observations is multifactorial and not clearly defined. In addition, while a

Disclosure: The authors have no conflicts of interest to disclose.
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Clin Sports Med 36 (2017) 703–715
http://dx.doi.org/10.1016/j.csm.2017.05.004 **sportsmed.theclinics.com**

consensus exists as to the efficacy of ACL prevention programs in young female athletes, the optimization of program prescription is still unclear.

THE COST OF ANTERIOR CRUCIATE LIGAMENT RUPTURE

The incidence of primary ACL ruptures varies from 250,000 to 300,000 annually. Female athletes are not only at higher risk of sustaining an initial ACL rupture but also of contralateral ACL tear and reconstruction.[3,4] The Multicenter Orthopaedic Outcomes Network cohort found that females were more likely to need another ACL surgery[5,6] after the index procedure in a 7-year follow-up, with 0.7 ACL injuries per season for female soccer players versus 0.4 for men.[7]

Retear rates are also higher in female athletes younger than 25 years and with smaller primary grafts (less than 8 mm in diameter).[8] Even after successful primary reconstruction, 28% of all female soccer players and 34% of reconstructed players who returned to sport had a second ACL tear.[9] These injuries account for more than $2 billion in annual surgical and rehabilitative care dollars.[10,11]

In addition to the financial cost of ACL rupture and reconstruction, athletes experience extensive personal and social costs of injury and rehabilitation with loss of mobility, pain, social isolation, and alterations in scholastic performance, with 36% failing an examination after return from surgery performed midsemester, compared with 0% with surgery performed during a holiday.[12] In addition, female athletes are less likely to return to sports participation after ACL surgery when compared with boys.[13]

CAUSE OF HIGHER ANTERIOR CRUCIATE LIGAMENT RUPTURE RATES IN FEMALE ATHLETES

The reasons females are significantly more likely to experience ACL rupture are multidimensional and complex. Hagglund and Walden[14] identified age greater than 14 years, family history, and preseason knee pain as key risk factors for future rupture. Fatigue in young soccer players may also compromise athletes' neuromuscular feedback pathways and ability to quickly activate their muscles and respond to physical and visual cues, thus, increasing their injury rates.[15]

ACL injury, however, is not likely due to completely random events but is thought to follow specific repetitive movement patterns that result in more than 70% of all ACL ruptures in female athletes occurring in noncontact situations. The most commonly identified knee position during ACL rupture is an eccentric contraction of the quadriceps (quad) in stiff knee landing, a planted foot with internally rotated hip, valgus knee position in near full extension, and with an upright trunk position.[16–18]

Chappell and colleagues[19] identified quad dominance during landing as a factor resulting in increased ACL loading in landing. Quad dominance is an imbalance in the strength of the knee extensors and flexors as well as recruitment and coordination. This imbalance results in an athlete landing with the knee in nearly full extension and placing high forces across the ACL. Functional training focusing in part on hamstring strength has been shown to help improve dynamic valgus control of the knee and reduce the quad dominance patterns found in women.

In addition, biomechanics contribute to the risk. Excessive subtalar pronation and internal tibial rotation increase ACL strain and increase the detrimental effect of the female athletes' anterior knee laxity. These forces, in conjunction with puberty-related neuromuscular deficits, result in dynamic joint instability during unconscious proprioceptive movements. It is unlikely that a single high-energy movement into this position