

# Treatment For Anterior Cruciate Ligament (ACL) Injury

Ke Xu

University of Connecticut, Storrs, Connecticut, USA

**Abstract.** Anterior cruciate ligament (ACL) injuries are one of the most common injuries in basketball, soccer, and other adversarial sports. This article explores the complex epidemiologic patterns of ACL injuries (especially among female and youth athletes) and the various diagnostic tools used to identify ACL tears. Both conservative and surgical treatment options are highlighted, with attention to the rehabilitation process and psychological factors affecting recovery. The paper also highlights the case of NBA player Zach LaVine, whose successful return to the NBA after ACL reconstruction exemplifies the importance of structured.

**Keywords:** Anterior cruciate ligament injuries, epidemiologic patterns, diagnostic tools, treatment options, psychological factors.

## 1. Introduction

The knee joint is among the most intricate and load-bearing joints in the human body, with the anterior cruciate ligament (ACL) serving as a core structure for maintaining its stability. With the increasing popularity of competitive sports and public fitness, the incidence of ACL injuries has risen year by year, particularly in high-impact sports such as basketball, soccer, and skiing. ACL injuries not only cause physical pain for patients but also have significant psychological and lifestyle implications. To better prevent and manage this common sports-related injury, the medical community has conducted ongoing and in-depth research into the pathogenesis, diagnostic techniques, treatment strategies, and rehabilitation pathways for ACL injuries (Adams et al., 2012; van Melick et al., 2016). This paper systematically explores the epidemiological background, clinical diagnosis, treatment methods, and rehabilitation process of ACL injuries, and—based on current expert consensus—examines both the advantages and challenges encountered during treatment.

The epidemiological background of ACL injuries reveals clear patterns and risk factors. In terms of injury types, ACL injuries are predominantly tears, which can be either partial or complete, with the latter being more common. Due to its anatomical function, the ACL is particularly susceptible to injury during rotational, jumping, and cutting movements. Especially when the knee is in a flexed and internally rotated position, a sudden external force can easily result in ACL strain or rupture (Hewett et al., 2006). This mechanism is common during landing from a jump, abrupt changes of direction, or forced support actions during physical imbalance. For instance, basketball players who stop abruptly after a fast break or land on one leg after grabbing a rebound often place the knee in an unstable position, where even a small error in movement may lead to excessive stretching and tearing of the ACL. Additionally, due to the ligament's relatively poor blood supply, its self-healing capacity is limited (Monaco et al., 2010); thus, complete tears usually require surgical reconstruction.

In terms of population distribution, female athletes are significantly more likely to suffer ACL injuries than males. Statistics suggest that the risk for females is four to six times higher (Hewett et al., 2006). Several complex factors contribute to this discrepancy. Anatomically, females tend to have a larger Q-angle, the angle between the femur and patellar tendon, making them more prone to knee valgus during weight-bearing or landing, thereby increasing ACL strain (Myer et al., 2004). Furthermore, neuromuscular activation patterns differ between sexes; female athletes often show lower levels of coordinated activation between the quadriceps and hamstrings during landing, resulting in reduced knee stability under stress. Hormonal differences also play a role: elevated levels of estrogen, such as estradiol, have been shown to reduce the tensile strength of ligament collagen fibers, making the ACL laxer and more vulnerable to injury, especially during certain phases of the menstrual cycle (e.g.,

ovulation) (Hewett et al., 2006). Studies have also found that neuromuscular training tailored to lower limb control is often lacking in female-focused athletic programs, further increasing injury risk (Myer et al., 2004). Moreover, sociocultural limitations on female sports participation and unequal access to training resources may lead to systemic inadequacies in preventive training, placing female athletes at an inherent disadvantage. Therefore, gender-specific preventive strategies, including personalized strength training, dynamic control exercises, and posture correction programs, are essential to reducing injury risk. In addition, adolescent athletes—due to incomplete skeletal development and unstable technique—are also a high-risk group. Notably, nearly 70% of ACL injuries are non-contact in nature, caused not by external impact but by faulty landing mechanics or joint stress imbalance, offering critical theoretical support for injury prevention training (Ramski et al., 2014). Clinically, ACL injury diagnosis primarily relies on a combination of imaging and physical examination. Magnetic Resonance Imaging (MRI) is the most commonly used imaging tool, capable of clearly revealing ligament integrity, the extent of the tear, and any associated injuries such as meniscus or cartilage damage. Although MRI offers non-invasive and high-resolution benefits, it remains costly and has limitations in detecting acute-phase injuries. In settings with limited resources, X-rays are still useful as an initial tool to rule out fractures and bony abnormalities. In addition, physical assessments like the Lachman test, anterior drawer test, and pivot-shift test are effective tools for evaluating knee joint stability (Coffey & Bordoni, 2023; Vaudreuil et al., 2019). When performed by experienced clinicians, these tests have strong sensitivity and specificity. Accurate classification of the injury is critical, as it directly informs the choice of treatment strategy.

## **2. Treatments**

Treatment for ACL injuries falls into two main categories: conservative (non-surgical) and surgical. Conservative treatment is typically suitable for individuals with lower activity demands or for older adults. It focuses on using knee braces, physical therapy, and muscle strengthening exercises to enhance neuromuscular control around the joint and improve overall stability. In early recovery, braces help limit abnormal joint motion and provide psychological security. During everyday activities such as walking, light training, or stair descent, braces can also reduce joint stress and restore patient confidence. Physical therapy, a cornerstone of conservative care, involves customized plans developed by professionals to improve range of motion, reduce swelling, enhance proprioception, and correct compensatory movement patterns (Adams et al., 2012). Common techniques include cryotherapy, ultrasound, neuromuscular electrical stimulation (NMES) (Adams et al., 2012), and joint mobilization. Gentle range-of-motion exercises are used in early stages to prevent joint stiffness and maintain flexibility.

The goal of muscle strengthening is to improve the power and coordination of major muscle groups around the knee, such as the quadriceps, hamstrings, and gluteus maximus. Research shows that quadriceps inhibition is common following ACL injury, making quadriceps activation a key focus. Initial exercises often include isometric and isotonic contractions, along with resistance band-assisted training. These gradually progress to functional movements like single-leg balance, mini-squats, bridge exercises, and closed-chain activities (e.g., wall sits, straight leg raises). As rehabilitation progresses, dynamic stabilization training—such as balance board drills and single-leg hopping—is introduced to improve knee responsiveness and postural control, which is vital for both daily function and future injury prevention. With these stepwise interventions, non-surgical recovery can restore functional capacity in many cases, particularly in older adults, individuals with low activity levels, or skeletally immature adolescents.

However, for young, athletic, or high-demand individuals, surgical reconstruction is often the preferred option. Modern techniques generally employ arthroscopic ACL reconstruction using autografts (e.g., patellar tendon, hamstring tendon) or allografts (Adams et al., 2012; van Melick et al., 2016). Tunnel placement and graft fixation are performed with high precision to restore native joint kinematics. Postoperative recovery typically takes several months. Around the third month, patients transition from basic recovery to moderate-intensity functional training, this is a critical and

high-risk period that requires close supervision by medical professionals to avoid reinjury (van Melick et al., 2016).

### 3. Technology & Psychological Support in rehabilitation

Rehabilitation is an essential component of ACL treatment and is often the deciding factor in whether a patient can successfully return to sport. Modern rehabilitation goes beyond traditional physical exercises and incorporates digital tools and psychological support systems. Wearable devices, activity trackers, and rehabilitation apps allow patients to monitor their progress and receive remote guidance (van Melick et al., 2016). Virtual reality (VR) and biofeedback are also being explored to enhance proprioception and coordination. Importantly, many patients experience psychological barriers post-surgery, such as fear of reinjury and low confidence, which can be mitigated through structured mental health support and mindfulness training. A comprehensive rehabilitation system can significantly shorten recovery timelines, improve functional outcomes, and reduce recurrence risk. Many professional athletes have returned to elite competition following ACL tears, and the recovery journey of NBA star Zach LaVine is a particularly noteworthy example. Shortly after his diagnosis, LaVine underwent ACL reconstruction surgery and embarked on a year-long, structured rehabilitation program. In the early weeks, he managed swelling and pain with cryotherapy and brace immobilization, while engaging in passive stretching to prevent stiffness. As inflammation subsided, he initiated activation exercises for the quadriceps and hamstrings to prevent muscle atrophy. By the third month post-surgery, his rehabilitation incorporated balance drills and light resistance training to enhance proprioception. Around the six-month mark, LaVine resumed sport-specific drills, including jumping, cutting, pivoting, and contact movements. Notably, he emphasized mental recovery throughout the process, stating in interviews that fear of reinjury was more troubling than the physical pain. Through visualization, mindfulness, and confidence-building strategies under the guidance of sports psychologists, he overcame his anxiety. He also made significant technical adjustments, shifting from an explosiveness-based style to one focused on shooting and pacing. His three-point accuracy and playmaking abilities improved significantly.

In 2018, LaVine was traded to the Chicago Bulls, gradually regained his form, and was selected as an NBA All-Star for the first time in 2021. During the 2020–21 season, he averaged 27.4 points per game, with career-high shooting efficiency. His journey exemplifies how scientific rehabilitation, psychological support, and tactical adaptation can jointly contribute to a successful return to elite performance. LaVine's case demonstrates that an ACL tear no longer signifies the end of an athlete's career. With medical intervention, structured rehabilitation, mental resilience, and strategic evolution, athletes can not only return to sport but thrive (Rand, 2017).

### 4. Conclusions

In conclusion, the treatment system for ACL injuries has become increasingly refined, encompassing prevention, diagnosis, surgery, and rehabilitation. Despite its many advantages, such as minimally invasive surgical advances and enhanced rehabilitation tools, the treatment process still faces challenges, including high costs, prolonged recovery timelines, and patient compliance. Moving forward, treatment should focus on personalized pathways that account for individual anatomy, activity level, and psychological readiness. Preventive training should be incorporated early, particularly for adolescents and high-risk populations, to reduce injury incidence at the source. Only through interdisciplinary collaboration can ACL injury management become truly systematic and scientific (van Melick et al., 2016; Adams et al., 2012).

### References

- [1] Adams, D., Logerstedt, D. S., Hunter-Giordano, A., Axe, M. J., & Snyder-Mackler, L. 2012. Current concepts for anterior cruciate ligament reconstruction: A criterion-based rehabilitation progression. *The Journal of Orthopaedic and Sports Physical Therapy*, 42(7), 601–614.

- [2] Coffey, R., & Bordoni, B. 2023. Lachman Test. In StatPearls. *StatPearls Publishing*. <https://www.ncbi.nlm.nih.gov/books/NBK554415/>
- [3] Hewett, T. E., Myer, G. D., & Ford, K. R. 2006. Anterior cruciate ligament injuries in female athletes: Part 1, mechanisms and risk factors. *The American Journal of Sports Medicine*, 34(2), 299–311.
- [4] Monaco, E., Maestri, B., Vadalà, A., Iorio, R., & Ferretti, A. 2010. Return to sports activity after postoperative septic arthritis in ACL reconstruction. *The Physician and Sportsmedicine*, 38(3), 69–76.
- [5] Myer, G. D., Ford, K. R., & Hewett, T. E. 2004. Rationale and clinical techniques for anterior cruciate ligament injury prevention among female athletes. *Journal of Athletic Training*, 39(4), 352–364.
- [6] Rand, M. 2017. ACL surgery for Zach Lavine; a whole lot of questions to follow. Star Tribune. <https://www.startribune.com/acl-surgery-for-zach-lavine-a-whole-lot-of-questions-to-follow/413734943>
- [7] Ramski, D. E., Kanj, W. W., Franklin, C. C., Baldwin, K. D., & Ganley, T. J. 2014. Anterior cruciate ligament tears in children and adolescents: A meta-analysis of nonoperative versus operative treatment. *The American Journal of Sports Medicine*, 42(11), 2769–2776.
- [8] Melick, N., van Cingel, R. E. H., Brooijmans, F., Neeter, C., van Tienen, T., Hullegie, W., & Nijhuis-van der Sanden, M. W. G. 2016. Evidence-based clinical practice update: Practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *British Journal of Sports Medicine*, 50(24), 1506–1515.
- [9] Vaudreuil, N. J., Rothrauff, B. B., de Sa, D., & Musahl, V. 2019. The pivot shift: Current experimental methodology and clinical utility for anterior cruciate ligament rupture and associated injury. *Current Reviews in Musculoskeletal Medicine*, 12(1), 41–49.