fortune Journals

Narrative Review

JOURNAL OF ORTHOPAEDICS AND SPORTS MEDICINE

ISSN: 2688-5115

# Clinical Outcomes After Anterior Cruciate Ligament Reconstruction: Reinjury, Contralateral Tears, Osteoarthritis Risk, and Emerging Artificial Intelligence Applications

**Joseph N Salama, Sylvia Arce, Diego A L Garcia***

## Abstract

Anterior cruciate ligament (ACL) reconstruction is among the most frequently performed orthopedic procedures in sports medicine in the United States. Although advances in surgical techniques and rehabilitation protocols have improved short-term outcomes, long-term complications remain common. Recurrent ACL injury, contralateral ligament rupture, persistent symptoms, and the development of post-traumatic osteoarthritis represent significant challenges affecting patient outcomes and healthcare utilization. Large multicenter registries, including the Multicenter Orthopaedic Outcomes Network (MOON), have provided valuable insights into long-term outcomes following ACL reconstruction. In parallel, advances in musculoskeletal imaging and artificial intelligence are increasingly contributing to improved diagnosis, prognostication, and surgical planning. This review examines the epidemiology of ACL injuries in the United States, biomechanical mechanisms of injury, outcomes following reconstruction, reinjury patterns, contralateral injury risk, osteoarthritis progression, and emerging technological innovations in sports medicine.

**Keywords:** ACL; Reconstruction; Osteoarthritis; Grafts; Artificial intelligence

## Introduction

Anterior cruciate ligament (ACL) injury represents one of the most common and clinically significant knee injuries in athletic populations. The ligament plays a central role in maintaining both translational and rotational stability of the knee joint, and rupture often leads to functional instability, impaired athletic performance, and long-term joint degeneration if left untreated [1,2]. Consequently, ACL reconstruction has become the standard surgical treatment for symptomatic instability in young and active individuals. In the United States, approximately 200,000 to 250,000 ACL injuries occur annually, with more than 175,000 reconstructions performed each year [3,4]. The increasing participation of adolescents and young adults in organized sports has contributed to a rising incidence of ACL injuries over recent decades [5]. Although reconstruction typically restores knee stability, long-term outcomes remain heterogeneous. Recurrent ACL injury, contralateral ligament rupture, persistent pain, and the development of post-traumatic osteoarthritis (PTOA) remain common clinical challenges [6]. Large multicenter cohort studies and national registries have greatly expanded understanding of the natural history of ACL injury. Among these, the Multicenter Orthopaedic Outcomes Network (MOON) has provided

**Affiliation:**
Department of Radiology, University of Florida – Gainesville, FL, USA

***Corresponding Author:**
Diego A L Garcia, MD, Department of Radiology, University of Florida – Gainesville, FL, USA

**Citation:** Joseph N Salama, Sylvia Arce, Diego A L Garcia. Clinical Outcomes After Anterior Cruciate Ligament Reconstruction: Reinjury, Contralateral Tears, Osteoarthritis Risk, and Emerging Artificial Intelligence Applications. Journal of Orthopedics and Sports Medicine. 8 (2026): 98-104.

**Received:** March 13, 2026
**Accepted:** March 17, 2026
**Published:** March 18, 2026

Salama JN, et al. J Ortho Sports Med 2026
DOI:10.26502/josm.511500257

valuable long-term data regarding predictors of graft failure, functional recovery, and degenerative joint disease [3,31]. In parallel, advances in imaging and computational analysis are transforming sports medicine research. Machine learning and artificial intelligence techniques are increasingly used to analyze imaging datasets, predict outcomes, and improve surgical planning [55-60].

## Epidemiology of ACL Injury

ACL injuries represent a substantial proportion of sports-related knee trauma. Population-based studies have estimated incidence rates ranging from 30 to 78 ACL injuries per 100,000 persons annually, with significantly higher rates observed among athletes participating in pivoting sports [4]. Young athletes between the ages of 15 and 35 represent the most affected population. Participation in sports involving cutting, pivoting, and jumping movements—such as soccer, basketball, football, and skiing—dramatically increases injury risk [7]. Sex differences in ACL injury incidence have been extensively documented. Female athletes participating in comparable sports demonstrate two- to eight-fold higher ACL injury rates than their male counterparts [5]. These differences are thought to arise from a complex interaction of anatomical, hormonal, neuromuscular, and biomechanical factors [8,28]. From a healthcare perspective, ACL injuries represent a major economic burden. The direct surgical costs of ACL reconstruction in the United States exceed two billion dollars annually, excluding additional expenditures related to rehabilitation, imaging, revision procedures, and management of long-term osteoarthritis [6].

## Biomechanical Mechanisms of ACL Injury

Understanding the biomechanical mechanisms responsible for ACL rupture has been essential for improving both injury prevention strategies and surgical reconstruction techniques. The ACL functions primarily as a restraint to anterior tibial translation while also contributing to rotational stability of the knee joint [29]. During dynamic athletic movements such as landing or cutting, complex forces are transmitted through the knee, placing substantial stress on the ligament. Most ACL injuries occur through non-contact mechanisms, typically involving a combination of valgus knee collapse, internal tibial rotation, and anterior tibial translation during rapid deceleration or landing maneuvers [7]. High-speed video analysis of athletic injuries has confirmed that these mechanisms frequently occur when the knee is near full extension and the athlete attempts to rapidly change direction. Neuromuscular factors play a critical role in modulating these forces. Athletes demonstrating quadriceps dominance, poor trunk control, or inadequate hip strength may experience increased anterior tibial shear forces during landing tasks [8,67]. These deficits have become central targets of neuromuscular injury prevention programs.

Anatomical factors also contribute to injury risk. Increased posterior tibial slope has been associated with greater anterior tibial translation during weight-bearing activities, thereby increasing strain on the ACL [9]. Other structural features, including intercondylar notch morphology and ligamentous laxity, may further influence susceptibility to injury.

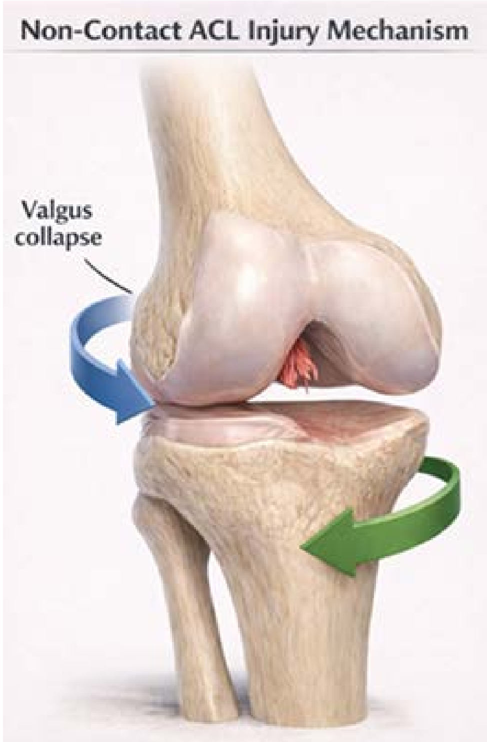


**Figure 1:** Biomechanical mechanism of non-contact anterior cruciate ligament injury. The typical injury pattern involves valgus knee collapse, internal tibial rotation, and anterior tibial translation during rapid deceleration or landing.

## Clinical Outcomes After ACL Reconstruction

Overall, ACL reconstruction results in significant improvements in knee stability and functional performance. Patient-reported outcome measures such as the International Knee Documentation Committee (IKDC) score and the Knee Injury and Osteoarthritis Outcome Score (KOOS) typically demonstrate substantial postoperative improvement. Despite these favorable results, return-to-sport outcomes remain variable. Systematic reviews indicate that approximately 65–75% of patients return to some level of sport participation, whereas only 50–60% return to their preinjury level of competition [10]. Multiple factors influence return-to-sport outcomes, including persistent neuromuscular deficits, psychological readiness, and fear of reinjury [74]. Persistent knee pain is also relatively common following reconstruction. Data from large cohorts suggest that 20–25% of patients report clinically significant knee pain several years after reconstruction [11].

Salama JN, et al. J Ortho Sports Med 2026
DOI:10.26502/josm.511500257

## Graft Failure and Recurrent ACL Injury

Graft rupture remains one of the most concerning complications following ACL reconstruction. Failure rates reported in the literature generally range between 5% and 13%, although higher rates are observed in younger athletes returning to high-risk sports [12,45]. Age represents one of the strongest predictors of graft failure. Athletes younger than 20 years who return to pivoting sports may experience reinjury rates approaching 20–25% within several years after surgery [13].

Technical factors also contribute to graft failure. Tunnel malposition remains a common cause of graft rupture, emphasizing the importance of anatomic reconstruction techniques that replicate native ACL insertion sites [14,70]. Revision ACL reconstruction presents additional challenges. Compared with primary reconstruction, revision procedures are associated with worse functional outcomes, lower rates of return to sport, and increased risk of additional knee pathology [15,73].

## Contralateral ACL Injury

In addition to graft rupture, injury to the contralateral knee represents an important complication following ACL reconstruction. Several studies have demonstrated that the risk of contralateral ACL injury may equal or exceed the risk of ipsilateral graft failure among young athletes returning to sport [16]. Biomechanical studies suggest that persistent asymmetries in strength, neuromuscular control, and landing mechanics may increase stress on the uninjured limb [17,69]. These findings underscore the importance of comprehensive rehabilitation programs emphasizing bilateral neuromuscular training and symmetrical movement patterns.

## Post-Traumatic Osteoarthritis

Post-traumatic osteoarthritis represents one of the most significant long-term consequences of ACL injury. Even when surgical reconstruction restores mechanical stability, degenerative joint changes frequently develop over time. Longitudinal studies have demonstrated that radiographic osteoarthritis develops in 30–50% of patients within 10–15 years after ACL reconstruction [18,47]. Meniscal injury is one of the strongest predictors of osteoarthritis progression [19,81]. The pathogenesis of PTOA is multifactorial. Acute injury to the menisci, articular cartilage, and subchondral bone initiates inflammatory pathways that may persist long after ligament reconstruction [20,50]. Altered joint biomechanics following ACL rupture may further contribute to abnormal load distribution across the tibiofemoral joint [30,62]. Advanced imaging techniques have revealed early structural changes in cartilage and subchondral bone following ACL injury, suggesting that degenerative processes may begin soon after the initial trauma [21,54].

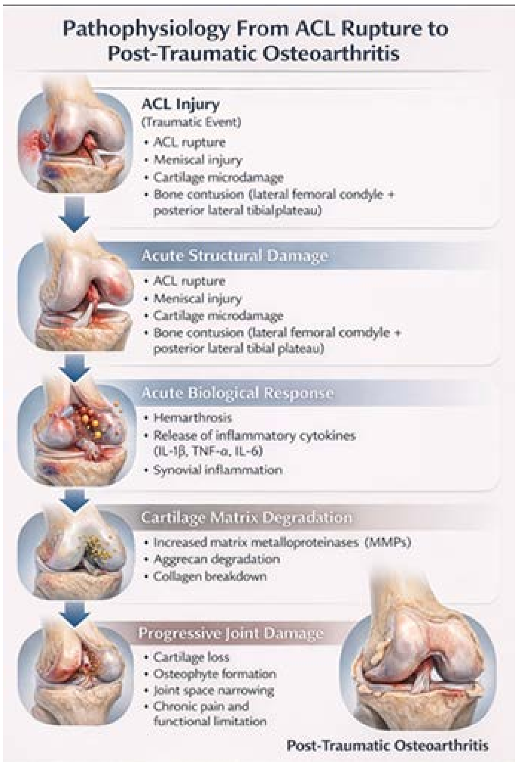


**Figure 2:** Pathophysiologic pathway from ACL rupture to post-traumatic osteoarthritis, highlighting the contribution of meniscal injury and altered joint biomechanics.

## Emerging Role of Artificial Intelligence

Artificial intelligence and machine learning technologies are increasingly being integrated into orthopedic research and clinical practice. These technologies offer powerful tools for analyzing complex clinical datasets and identifying patterns associated with surgical outcomes. Deep learning algorithms applied to magnetic resonance imaging have demonstrated high diagnostic accuracy for detecting ACL tears and associated knee injuries [56,57]. Automated image analysis may assist radiologists and surgeons in identifying subtle structural abnormalities that might otherwise be overlooked. Machine learning models have also been developed to predict postoperative outcomes after ACL reconstruction. By integrating clinical variables, imaging findings, and biomechanical data, these models may help identify patients at increased risk for graft failure or osteoarthritis progression [58,76]. Artificial intelligence is also being explored in surgical navigation. Computer vision algorithms capable of recognizing anatomical landmarks during arthroscopy may improve tunnel placement accuracy during ACL reconstruction [59]. As clinical registries and imaging databases continue to expand, the integration of artificial intelligence with longitudinal outcome data may enable more personalized approaches to ACL injury management.

**Table 1:** Major U.S. ACL Cohort Studies.

| Study | Sample Size | Follow-up | Key Findings |
|---|---|---|---|
| MOON cohort | >3500 | 10 years | Predictors of reinjury and osteoarthritis |
| Kaiser Permanente ACL registry | >20,000 | 5–10 years | Revision rates and graft outcomes |
| NCAA Injury Surveillance System | thousands | ongoing | Sport-specific injury epidemiology |

**Table 2:** Risk Factors for Second ACL Injury After Reconstruction.

| Category | Risk Factor | Mechanism | Clinical Relevance |
|---|---|---|---|
| **Patient Demographics** | Young age (<25 years) | Higher activity level and return to high-risk sports | Strongest predictor of graft rupture and contralateral ACL injury |
| | Female sex | Neuromuscular and anatomical factors (valgus mechanics, hormonal influence) | Higher risk, particularly in pivoting sports |
| | High activity level | Exposure to cutting and pivoting movements | Increased cumulative stress on graft |
| **Anatomical Factors** | Increased posterior tibial slope | Increased anterior tibial translation during weight-bearing | Associated with higher graft failure rates |
| | Narrow intercondylar notch | Mechanical impingement risk | May increase graft stress |
| | Generalized ligamentous laxity | Reduced passive joint stability | Higher reinjury risk |
| **Surgical Factors** | Tunnel malposition | Non-anatomic graft placement alters biomechanics | One of the most common causes of graft failure |
| | Graft choice (allograft vs autograft) | Allografts may demonstrate slower biologic incorporation | Higher failure rates in young athletes |
| | Graft size (<8 mm) | Reduced structural strength | Associated with higher rupture rates |
| **Rehabilitation Factors** | Early return to sport (<9 months) | Incomplete graft maturation and neuromuscular recovery | Significantly increases reinjury risk |
| | Quadriceps weakness | Altered knee loading during landing and cutting | Persistent biomechanical asymmetry |
| | Neuromuscular deficits | Poor dynamic knee control | Increased valgus loading patterns |
| **Biomechanical Factors** | Dynamic knee valgus | Increased ACL strain during landing | Common in athletes with poor hip control |
| | Asymmetrical landing mechanics | Increased load on reconstructed knee | Predictive of second ACL injury |
| | Trunk control deficits | Altered center-of-mass mechanics | Contributes to valgus collapse |
| **Psychological Factors** | Fear of reinjury | Alters movement mechanics and return-to-sport behavior | Associated with delayed or abnormal functional recovery |
| | High psychological readiness without objective recovery | Premature return to sport | Increased injury risk |
| **Sport-Specific Factors** | Participation in pivoting sports | Cutting, jumping, and deceleration forces | Highest reinjury rates observed in soccer, basketball, and football |
| | Competitive athletes | Higher intensity and frequency of play | Greater exposure to reinjury mechanisms |

Salama JN, et al. J Ortho Sports Med 2026
DOI:10.26502/josm.511500257

## Future Directions

Future advances in ACL injury management will likely arise from multidisciplinary collaboration among orthopedic surgeons, radiologists, biomechanical engineers, and data scientists. Biologic augmentation strategies aimed at improving graft integration and ligament healing are actively being investigated. In addition, improved rehabilitation protocols emphasizing neuromuscular recovery and symmetrical movement patterns may help reduce reinjury risk. The integration of imaging biomarkers with artificial intelligence algorithms may allow clinicians to identify patients at risk for post-traumatic osteoarthritis and implement early interventions to preserve joint health.

## Conclusion

ACL reconstruction remains a cornerstone of modern sports medicine, enabling many athletes to regain knee stability and return to physical activity. Nevertheless, recurrent injury, contralateral ligament rupture, and post-traumatic osteoarthritis remain important long-term challenges. Advances in biomechanics, imaging technology, and artificial intelligence provide new insights into the mechanisms underlying these outcomes and may ultimately improve prevention, surgical treatment, and long-term joint preservation.

## References

1. Griffin LY, Agel J, Albohm MJ, et al. Noncontact anterior cruciate ligament injuries: risk factors and prevention strategies. J Am Acad Orthop Surg 8 (2000):141-150.
2. Miyasaka KC, Daniel DM, Stone ML. The incidence of knee ligament injuries in the general population. Am J Knee Surg 4 (1991):17-21.
3. Spindler KP, Huston LJ, Wright RW, et al. The MOON ACL reconstruction cohort: longitudinal outcomes. Am J Sports Med 39 (2011): 289-294.
4. Sanders TL, Maradit Kremers H, Bryan AJ, et al. Incidence of ACL tears and reconstruction: population-based study. Am J Sports Med 44 (2016): 1502-1507.
5. Hewett TE, Myer GD, Ford KR. Anterior cruciate ligament injuries in female athletes: part 1, mechanisms and risk factors. Am J Sports Med 34 (2006): 299-311.
6. Frobell RB, Roos EM, Roos HP, et al. Treatment for acute ACL tear: randomized trial. BMJ 340 (2010): c298.
7. Boden BP, Dean GS, Feagin JA, et al. Mechanisms of ACL injury. Am J Sports Med 28 (2000): 526-34.
8. Hewett TE, Lindenfeld TN, Riccobene JV, et al. Neuromuscular training and ACL injury prevention. Am J Sports Med 27 (1996): 699-706.
9. Hashemi J, Chandrashekar N, Gill B, et al. Tibial slope and ACL injury risk. J Orthop Res 28 (2010): 718-23.
10. Ardern CL, Webster KE, Taylor NF, et al. Return to sport following ACL reconstruction: a systematic review. Br J Sports Med 45 (2011): 596-606.
11. MOON Knee Group. Patient-reported outcomes after ACL reconstruction. Am J Sports Med 41 (2013): 1029-1036.
12. Wiggins AJ, Grandhi RK, Schneider DK, et al. Risk of secondary ACL injury: a systematic review and meta-analysis. Am J Sports Med 44 (2016): 1869-1876.
13. Paterno MV, Rauh MJ, Schmitt LC, et al. Incidence of second ACL injuries in young athletes. Am J Sports Med 42 (2014): 1569-1576.
14. Fu FH, van Eck CF, Tashman S, et al. Anatomic ACL reconstruction: a systematic review. Arthroscopy 31 (2015): 1176-1185.
15. Magnussen RA, Wright RW, Spindler KP. Revision ACL reconstruction outcomes: a systematic review. Am J Sports Med 40 (2012): 1195-1202.
16. Webster KE, Feller JA. Exploring the high reinjury rate in younger athletes. Sports Med 46 (2016): 1057-1064.
17. Paterno MV, Schmitt LC, Ford KR, et al. Biomechanical predictors of second ACL injury. Am J Sports Med 38 (2010): 1968-1975.
18. Lohmander LS, Englund PM, Dahl LL, et al. High prevalence of osteoarthritis following ACL injury. Arthritis Rheum 56 (2007): 128-136.
19. Øiestad BE, Engebretsen L, Storheim K, et al. Knee osteoarthritis after ACL injury: a systematic review. Am J Sports Med 37 (2009): 1434-1443.
20. Culvenor AG, Collins NJ, Guermazi A, et al. Early cartilage changes after ACL reconstruction. Br J Sports Med 49 (2015): 1188-1193.
21. Roemer FW, Kwoh CK, Hannon MJ, et al. MRI biomarkers of osteoarthritis progression. Radiology 276 (2015): 533-542.
22. Crema MD, Roemer FW, Marra MD, et al. MRI assessment of cartilage and meniscal injury. Radiographics 31 (2011): 1325-1340.
23. Kijowski R, Tuite M, Sanford M. Magnetic resonance imaging of ACL injury. Radiology 240 (2006): 846-853.
24. Brophy RH, Wright RW, Huston LJ, et al. Return to sport after ACL reconstruction. Am J Sports Med 40 (2012): 2513-2518.
25. Wright RW, Magnussen RA, Dunn WR, et al. Ipsilateral

Salama JN, et al. J Ortho Sports Med 2026
DOI:10.26502/josm.511500257

graft failure vs contralateral injury: a systematic review. J Bone Joint Surg Am 93 (2011): 1151-1157.

26. Shelbourne KD, Gray T. Minimum 10-year results after ACL reconstruction. Am J Sports Med 37 (2009): 902-910.

27. Noyes FR, Barber-Westin SD. Long-term outcomes after ACL injury. Clin Sports Med 29 (2010): 235-250.

28. Myer GD, Ford KR, Hewett TE. Neuromuscular training for ACL prevention. Clin Sports Med 27 (2008): 425-48.

29. Markolf KL, Burchfield DM, Shapiro MM, et al. Combined knee loading and ACL strain. J Orthop Res 13 (1995): 930-935.

30. Andriacchi TP, Mündermann A. Knee biomechanics and osteoarthritis. Ann Biomed Eng 34 (2006): 373-382.

31. Spindler KP, Wright RW. Clinical practice in ACL reconstruction. J Bone Joint Surg Am 90 (2008): 2468-2479.

32. Brophy RH, Schmitz L, Wright RW, et al. Meniscal tears associated with ACL injury. Am J Sports Med 40 (2012): 1759-1764.

33. Kaeding CC, Pedroza AD, Reinke EK, et al. Risk factors for ACL graft failure. Am J Sports Med 43 (2015): 1868-1875.

34. Cox CL, Huston LJ, Dunn WR, et al. Predictors of outcomes after ACL reconstruction. Am J Sports Med 42 (2014): 637-644.

35. Dunn WR, Spindler KP. Predictors of activity level after ACL reconstruction. Am J Sports Med 38 (2010): 2050-206.

36. Filbay SR, Crossley KM, Ackerman IN. Quality of life after ACL injury: a systematic review. Sports Med 44 (2014): 1409-1424.

37. Pinczewski LA, Lyman J, Salmon LJ, et al. 10-year outcomes after ACL reconstruction. Am J Sports Med 35 (2007): 564-570.

38. Salmon LJ, Russell VJ, Refshauge K, et al. Long-term outcomes after ACL reconstruction. Am J Sports Med 34 (2006): 1241-1248.

39. Raines BT, Naclerio E, Sherman SL. Management of ACL injuries. Orthop Clin North Am. 2017;48(3):289-300.

40. Musahl V, Karlsson J. ACL reconstruction techniques. Knee Surg Sports Traumatol Arthrosc 27 (2019): 351-353.

41. van Eck CF, Schkrohowsky JG, Working ZM, et al. Prospective analysis of ACL reconstruction techniques. Am J Sports Med 40 (2012): 608-614.

42. Kvist J. Rehabilitation following ACL injury. Sports Med 34 (2004): 269-280.

43. Risberg MA, Lewek M, Snyder-Mackler L. Functional outcomes after ACL reconstruction. J Orthop Sports Phys Ther 34 (2008): 442-454.

44. Grindem H, Snyder-Mackler L, Moksnes H, et al. Timing of return to sport after ACL reconstruction. Br J Sports Med 50 (2016): 928-935.

45. Webster KE, Feller JA, Leigh WB, et al. Younger patients are at increased risk of graft rupture. Am J Sports Med 42 (2014): 2142-2147.

46. Salmon LJ, Heath E, Akrawi H, et al. 20-year outcomes after ACL reconstruction. Am J Sports Med 46 (2018): 2123-2130.

47. Culvenor AG, Ruhdorfer A, Juhl C, et al. Knee osteoarthritis following ACL injury: a systematic review. Br J Sports Med 53 (2019): 567-576.

48. Oiestad BE, Holm I, Aune AK, et al. Knee function and OA after ACL injury. Am J Sports Med 38 (2010): 2216-2223.

49. Englund M, Roos EM, Lohmander LS. Impact of meniscal injury on OA development. Arthritis Rheum 48 (2003): 2194-2202.

50. Guermazi A, Roemer FW, Hayashi D. Imaging of osteoarthritis. Radiology 261 (2011): 20-35.

51. Guermazi A, Hayashi D, Roemer FW, et al. MRI assessment of osteoarthritis. Nat Rev Rheumatol 9 (2013): 482-493.

52. Kijowski R, Blankenbaker DG, Davis KW, et al. MRI features of graft complications. AJR Am J Roentgenol 195 (2010): 15-23.

53. Recht MP, Kramer J. MR imaging of the postoperative knee. Radiology 224 (2002): 671-682.

54. Crema MD, Roemer FW, Guermazi A. MRI assessment after ACL injury. Radiology 271 (2014): 325-341.

55. Pedoia V, Norman B, Mehany SN, et al. Machine learning in orthopedic imaging. Radiology 290 (2019): 639-649.

56. Namiri NK, Lui H, Yagnik G, et al. Deep learning for ACL tear detection on MRI. Radiol Artif Intell 2 (2020): e190126.

57. Bien N, Rajpurkar P, Ball RL, et al. Deep-learning MRI diagnosis of knee injuries. PLoS Med 15 (2018): e1002699.

58. Tolpadi AA, Pedoia V, Majumdar S. Machine learning prediction of knee OA progression. Radiology 294 (2020): 386-394.

59. Wang S, Zhou Y, Li X, et al. Artificial intelligence in arthroscopic surgery. Arthroscopy 38 (2022): 1025-1034.

60. Pedoia V, Majumdar S. Imaging biomarkers of joint degeneration. Radiology 298 (2021): 269-280.

61. Culvenor AG, Crossley KM, Felson DT. Risk of osteoarthritis after ACL injury. Curr Opin Rheumatol 31 (2019): 78-84.

62. Andriacchi TP, Favre J. Biomechanics of knee osteoarthritis. J Orthop Res 32 (2014): 803-809.

63. Krych AJ, Reardon PJ, Johnson NR, et al. Activity levels after ACL reconstruction. Am J Sports Med 44 (2016): 2040-2045.

64. Filbay SR, Ackerman IN, Russell TG, et al. Long-term outcomes after ACL injury. Am J Sports Med 42 (2014): 2412-2420.

65. Webster KE, Nagelli CV, Hewett TE, Feller JA. Factors associated with reinjury. Sports Med 48 (2018): 15-24.

66. Nagelli CV, Hewett TE. Return-to-sport criteria after ACL reconstruction. Clin Sports Med 36 (2017): 119-128.

67. Myer GD, Ford KR, Barber Foss KD, et al. Neuromuscular deficits after ACL injury. Am J Sports Med 42 (2014): 383-390.

68. Bates NA, Schilaty ND, Nagelli CV, et al. ACL injury mechanisms revisited. Sports Med 47 (2017): 2473-2485.

69. Beaulieu ML, Lamontagne M, Xu L. Knee biomechanics during landing. J Biomech 48 (2015): 1915-1921.

70. Musahl V, Rahnemai-Azar AA, Costello J, et al. Surgical decision-making in ACL reconstruction. Knee Surg Sports Traumatol Arthrosc 24 (2016): 672-681.

71. Karlsson J, Irrgang JJ, van Eck CF, et al. Future of ACL research. Knee Surg Sports Traumatol Arthrosc 27 (2019): 3415-3418.

72. Spindler KP, Huston LJ, Wright RW, et al. Predictors of ACL graft rupture from the MOON cohort. Am J Sports Med 42 (2014): 2351-2357.

73. Dunn WR, Lyman S, Lincoln AE, et al. Multicenter ACL revision outcomes. J Bone Joint Surg Am 92 (2010): 2388-2395.

74. Ardern CL, Glasgow P, Schneiders A, et al. Consensus on return to sport after ACL reconstruction. Br J Sports Med 50 (2016): 926-932.

75. Webster KE, Hewett TE. Meta-analysis of ACL reinjury rates. Sports Med 49 (2019): 449-460.

76. Pedoia V, Li X, Majumdar S. AI analysis of cartilage degeneration. Radiology 297 (2020): 326-336.

77. Tiulpin A, Saarakkala S. Automatic knee MRI analysis with deep learning. IEEE Trans Med Imaging 37 (2018): 2045-2055.

78. Antony J, McGuinness K, O'Connor NE, Moran K. Deep learning for knee MRI analysis. Med Image Anal 39 (2017): 114-125.

79. Norman B, Pedoia V, Majumdar S. Quantitative MRI in knee degeneration. Radiology 289 (2018): 712-721.

80. Roemer FW, Guermazi A. Imaging of post-traumatic osteoarthritis. Radiology 300 (2021): 16-27.

81. Englund M. The role of meniscus in osteoarthritis development. Nat Rev Rheumatol 6 (2010): 82-87.

82. Frobell RB, Roos EM, Roos HP, et al. Natural course of ACL injury. N Engl J Med 369 (2013): 1261-1270.

83. Barber-Westin SD, Noyes FR. Long-term follow-up after ACL injury. Sports Med Arthrosc Rev 25 (2017): 200-210.

84. Lynch AD, Logerstedt DS, Grindem H, et al. Consensus on rehabilitation after ACL reconstruction. Br J Sports Med 49 (2015): 936-942.

85. Snyder-Mackler L, Delitto A, Bailey SL, et al. Strength deficits after ACL reconstruction. J Orthop Sports Phys Ther 21 (1995): 334-341.

86. Grindem H, Snyder-Mackler L, Risberg MA. Rehabilitation strategies after ACL reconstruction. Br J Sports Med 50 (2016): 910-915.

87. Kaeding CC, Aros B, Pedroza A, et al. Allograft vs autograft ACL reconstruction outcomes. Am J Sports Med 39 (2011): 1210-1217.

88. Spindler KP, Wright RW, Huston LJ, et al. 10-year outcomes from MOON cohort. Am J Sports Med 46 (2018): 1583-1591.

89. Culvenor AG, Eckstein F, Wirth W, et al. Structural knee changes after ACL injury. Radiology 291 (2019): 733-741.

90. Kijowski R, Blankenbaker DG. Imaging evaluation of ACL graft complications. Radiol Clin North Am 51 (2013): 445-458.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license 4.0

**Citation:** Joseph N Salama, Sylvia Arce, Diego A L Garcia. Clinical Outcomes After Anterior Cruciate Ligament Reconstruction: Reinjury, Contralateral Tears, Osteoarthritis Risk, and Emerging Artificial Intelligence Applications. Journal of Orthopedics and Sports Medicine. 8 (2026): 98-104.