

EARLY ONSET GENU OSTEOARTHRITIS IN MALE RECREATIONAL ATLET WITH HISTORY OF ANTERIOR CRUCIATE LIGAMENT AND MENISCUS TEAR: AN EVIDENCE BASED CASE REPORT

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ABSTRACT

Introduction: Post-traumatic osteoarthritis (PTOA) is a long-term complication of knee injuries, particularly anterior cruciate ligament (ACL) and meniscal tears. This evidence-based case report aimed to analyze the factors contributing to early-onset genu osteoarthritis in a male recreational athlete based on current scientific evidence. **Case Presentation:** A 35-year-old man with a history of right knee injury during recreational soccer experienced persistent pain and restricted range of motion. Radiographs revealed grade II right knee osteoarthritis, while magnetic resonance imaging demonstrated ACL and medial and lateral meniscal tears. The patient had grade I obesity, lower-extremity malalignment, quadriceps and hip abductor muscle weakness, and a history of incomplete rehabilitation. **Methods:** The clinical question was formulated using the PICO framework. Evidence was searched in PubMed, Cochrane, and Scopus databases using a PRISMA-based screening process. Eligible studies included English-language randomized controlled trials (RCTs) and systematic reviews, with or without meta-analysis, published within the previous five years. **Results:** Integration of the clinical findings and scientific evidence indicated that previous ACL and meniscal injuries, mechanical instability, lower-extremity kinetic chain dysfunction, obesity, and discontinuous rehabilitation contributed to PTOA progression. The interaction of these factors may increase abnormal joint loading and accelerate articular cartilage degeneration. **Conclusion:** This case illustrates early-onset post-traumatic genu osteoarthritis involving interacting structural, biomechanical, and metabolic risk factors. Management should include structured neuromuscular rehabilitation, weight management, and sports activity modification to optimize knee function and reduce the risk of degenerative progression.

Keywords: Anterior Cruciate Ligament Injury; Meniscal Injury; Early-Onset Genu Osteoarthritis; Post-Traumatic Osteoarthritis.

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INTRODUCTION

Early post-traumatic genu osteoarthritis is a debilitating clinical consequence of sports injuries, particularly anterior cruciate ligament (ACL) tears and meniscal injuries in recreational athletes. (Hollis *et al.*, 2023; Losciale *et al.*, 2026). Patient-reported diagnostic criteria indicate that the prevalence of early knee osteoarthritis symptoms is high, ranging from 28% to 54% approximately six months after ACL reconstruction (ACLR) (Ward *et al.*, 2023). These early symptoms may persist from the mid-recovery period, between six and 12 months after surgery (Harkey *et al.*, 2024). Further structural evidence indicates that 30.4% of patients have patellofemoral cartilage lesions by the end of the first year after ACLR (Schache *et al.*, 2023). Although studies have often examined sex-related differences in cartilage composition that may make women more susceptible to degeneration, male recreational athletes also remain at considerable risk of post-traumatic osteoarthritis because of the physical intensity of injury and anatomical and biomechanical factors affecting the knee during high-impact sports (Di Martino *et al.*, 2024).

Several risk factors have been identified as contributing to early-onset genu osteoarthritis in male athletes. A history of acute injury, such as ACL and meniscal damage, is a major predictor of PTOA compared with idiopathic osteoarthritis. Genetic factors may also influence risk, as some individuals have an inherited predisposition that makes them more susceptible to developing osteoarthritis over their lifetime after knee trauma (Hollis *et al.*, 2023). In addition, weight gain and age are risk factors for worsening clinical outcomes, including knee pain, functional decline, and progressive cartilage degeneration (Solanki *et al.*, 2023). Another contributing factor is suboptimal neuromuscular recovery. Although thigh muscle strength often improves during the first 12 months after injury, this improvement is not necessarily strongly associated with overall functional recovery of the leg, meaning that joint stability may remain compromised (Losciale *et al.*, 2026).

When these risk factors and structural injuries are not adequately addressed through conservative treatment, such as exercise, biomechanical dysfunction may develop or progress. An ACL-deficient knee is not only unstable in the anteroposterior direction; it may also exhibit mechanical abnormalities in the frontal plane. In vivo evidence has demonstrated abnormally increased varus loading and medial displacement of the tibia during demanding functional activities, such as squatting (Agostinone *et al.*, 2021). These kinematic abnormalities indicate that knee loading may remain altered after surgery (Murrell-Smith *et al.*, 2025). In the patellofemoral joint, an apparently paradoxical finding has been reported: lower knee contact forces during physical activities such as jumping in the first year after surgery were associated with a 1.55-fold higher risk of progressive knee cartilage deterioration over the following five years (Schache *et al.*, 2023).

With regard to preventing joint degeneration, no significant difference in efficacy has been demonstrated between surgical reconstruction and nonoperative management. A meta-analysis found no significant difference in the overall prevalence or incidence of knee osteoarthritis between patients who underwent ACLR and those who received conservative management.^{9,10} Although ACLR has been reported to provide better functional stability and reduce the likelihood of secondary surgery for meniscal tears, progressive cartilage damage remains difficult to prevent completely with currently available treatments (Cuzzolin *et al.*, 2021; Ridha *et al.*, 2025). The development and progression of early osteoarthritis can lead to several adverse outcomes for recreational athletes. Persistent symptoms can reduce quality of life and contribute to chronic pain (Harkey *et al.*, 2024). Osteoarthritis may also lead to

bone damage and hinder return to sport (Losciale *et al.*, 2026)A major long-term complication of PTOA following complex ACL and meniscal injuries is permanent joint damage, which may ultimately necessitate total knee replacement (TKR) (Hollis *et al.*, 2023; Solanki *et al.*, 2023).

RESEARCH METHOD

A 35-year-old man presented with right knee pain that had persisted since an injury sustained while playing soccer in 2022. The pain began suddenly, accompanied by a “popping” sound, when he jumped and collided with an opponent. Physical examination indicated class I obesity and a high body fat percentage. Postural assessment using the NYPRS showed anterior pelvic tilt, bilateral genu varum, and bilateral toe-out, with an NYPRS score of 70/100. Right knee flexion and extension range of motion (ROM) were more limited than on the left. Manual muscle testing showed that right vastus medialis obliquus (VMO) and quadriceps strength were graded 4, compared with 5 on the left. Special knee tests showed positive anterior drawer and Lachman tests on the right, as well as positive Thessaly and McMurray tests in the right medial compartment. Crepitus was present in both knees. Gait analysis showed body sway while walking, internal rotation of the right hip, genu varum—particularly on the right—and bilateral toe-out, more pronounced on the right. A positive Trendelenburg sign on the right suggested possible right hip abductor weakness. Right knee radiographs in 2025 showed grade II genu osteoarthritis. MRI in 2026 demonstrated a right ACL rupture and medial and lateral meniscal tears. The patient had previously undertaken muscle-strengthening exercises, but the program was irregular and was discontinued before completion. He had never undergone surgery. He continued to experience pain and restricted movement, particularly when playing soccer and kicking.

Clinical Question

What is the effect of a history of ACL and meniscal injuries on the occurrence of early-onset genu osteoarthritis in adults?

Table 1. PICO formulation of the clinical question

Population	Intervention	Comparisson	Outcome
Men or women younger than 40 years with an ACL or meniscal injury	Meniscal injury; ACL injury; combined ACL and meniscal injuries	No history of ACL injury, meniscal injury, or either injury	Early-onset knee osteoarthritis (<40 years)

RESULT AND DISCUSSION

This evidence-based case report (EBCR) integrates the patient’s clinical findings with relevant scientific evidence to address the clinical question concerning the association between ACL and meniscal injuries and early-onset genu osteoarthritis. The clinical question was formulated using the Population, Intervention/Exposure, Comparison, and Outcome (PICO) framework, as shown in Table 1. The literature search was conducted in three electronic databases: PubMed, Scopus, and the Cochrane Library. The search strategy combined terms related to ACL injury, meniscal injury, knee osteoarthritis, and young adult populations. Keywords were combined using the Boolean operators AND and OR to identify articles relevant to the clinical question. Search terms included “anterior cruciate ligament

injury,” “meniscal injury,” “knee osteoarthritis,” “post-traumatic osteoarthritis,” and “early-onset osteoarthritis.” Search syntax was adapted for each database.

The inclusion criteria were English-language articles published within the five years preceding the search, using a randomized controlled trial (RCT) or systematic review design, with or without meta-analysis, and available in full text. Articles had to be relevant to the association between ACL and/or meniscal injuries and the occurrence, progression, or risk factors of knee osteoarthritis. Exclusion criteria included animal studies, nonsystematic reviews, conference abstracts, and studies not published in full. Articles that were irrelevant to the clinical question or did not meet the eligibility criteria were also excluded.

Identification, screening, eligibility assessment, and final article selection were documented using a PRISMA flow diagram, as shown in Figure 1. Articles identified through each database and any additional search methods were recorded separately. After duplicates were removed, articles were screened by title and abstract. Full-text assessment was then conducted for articles meeting the initial criteria. Eligible articles were narratively synthesized, taking into account study design, population characteristics, ACL and/or meniscal injury exposure, knee osteoarthritis outcomes, and relevance to the patient’s clinical findings. The findings were integrated with the structural, biomechanical, and metabolic factors identified in this case.

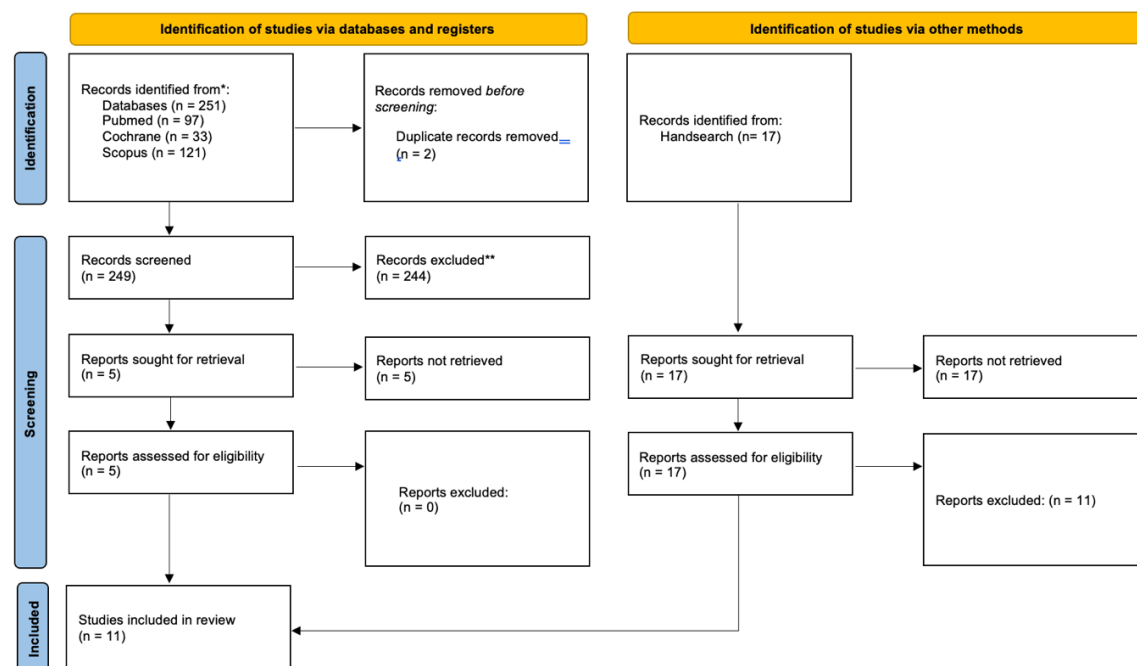


Figure 1. PRISMA flow diagram of the literature search conducted in May 2026.

DISCUSSION

The patient’s clinical presentation is consistent with post-traumatic osteoarthritis (PTOA), or early secondary genu osteoarthritis, associated with a history of complex knee injury. The patient sustained right ACL and meniscal tears while playing soccer in 2022, approximately four years before the clinical evaluation in 2026. Radiographs in 2025 showed grade II right genu osteoarthritis, while MRI in 2026 confirmed right ACL rupture and

medial and lateral meniscal tears. Thus, the structural injuries preceded the radiographic identification of osteoarthritis. Acute knee injury is an important risk factor for PTOA compared with idiopathic osteoarthritis.¹ Persistent pain and limited range of motion (ROM) indicate functional impairment requiring ongoing assessment and management. Crepitus in both knees should also be considered during clinical evaluation; however, it is insufficient to establish bilateral cartilage damage without appropriate investigations.

Table 2. Findings from studies included in the evidence-based case review

	Study, population, and methods	Findings
Harkey, et al. (2024)	Evaluated the time course and persistence of early knee osteoarthritis (OA) symptoms during mid-recovery (6–12 months) after ligament surgery (ACLR). The study included 82 patients aged 13–35 years. Early OA symptoms were classified using the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire and the Luyten criteria.	Evaluated the time course and persistence of early knee osteoarthritis (OA) symptoms during mid-recovery (6–12 months) after ligament surgery (ACLR). The study included 82 patients aged 13–35 years. Early OA symptoms were classified using the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire and the Luyten criteria.
Agostinone, et al. (2020)	Examined how isolated ACL injury affects knee bone kinematics during weight-bearing activities of daily living. Eight patients' injured knees were compared with their healthy contralateral knees using radiostereometric analysis (RSA). Participants performed a forward step and a single-leg squat.	ACL-deficient knees showed significant frontal-plane movement abnormalities during squatting, including abnormal medial displacement of the tibia and increased varus loading. This suggests that ACL injury affects not only anteroposterior stability but also lateral knee loading.
Schache, et al. (2022)	Investigated the association between mechanical loading of the patellofemoral joint (PFJ) and the occurrence and progression of early PFJ OA after ACLR. Forty-six participants (mean age 26 years) underwent knee MRI and biomechanical testing one year after ACLR; 32 were followed through year five. Joint loading was analyzed during the landing phase of a forward hop.	Contrary to expectations, lower peak PFJ contact force at one year was associated with a high prevalence of cartilage lesions (approximately 30.4%). Participants with lower loading also had a 1.55-fold higher risk of OA progression between years one and five after surgery.
Losciale, et al. (2025)	Examined whether recovery or changes in thigh muscle strength were associated with changes in leg performance and function over time after sports-related injury. The longitudinal study followed 106 active adolescents aged 11–19 years at injury and at	There was little or no significant longitudinal association between gains in concentric thigh muscle strength and improvements in hopping performance, balance, or patient-reported function during the first year after injury.

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	six and 12 months. The researchers assessed thigh extensor and flexor strength, triple-hop distance, Y-Balance Test (YBT) performance, and patient-reported KOOS scores.	
Harkey, et al. (2022)	Estimated and compared the proportion of patients classified as having early knee OA symptoms after ACLR using two questionnaire criteria: Luyten and Englund. Data were collected 5.0–7.9 months after ACLR. Scores were evaluated using the original thresholds and the Patient Acceptable Symptom State (PASS) thresholds for each method.	The Luyten criteria identified a significantly higher prevalence of early OA symptoms (43%–54%) than the Englund criteria (28%–42%). Regardless of the measure used, a substantial proportion—28%–54%—of patients reported notable OA symptoms at approximately six months after ACLR.

The early progression of OA in this patient may have been driven by interactions among mechanical, structural, and metabolic risk factors. Metabolically, the patient had class I obesity (BMI 29 kg/m²), a waist circumference of 95 cm, and high subcutaneous and visceral fat levels. Adipose tissue accumulation not only increases static and dynamic compressive loading on the knee joint but may also promote chronic low-grade systemic inflammation through adipokine secretion, accelerating extracellular cartilage matrix degradation. Increased body weight and obesity are strongly associated with worsening pain, progressive loss of joint function, and an increased likelihood of requiring total knee replacement (TKR) in the future (Solanki *et al.*, 2023). Although the patient's anthropometric measurements of the musculoskeletal system appeared balanced—with no significant right–left differences in patellar circumference or VMO and quadriceps measurements—this does not necessarily reflect actual functional capacity or neuromuscular control. This is consistent with evidence that recovery of thigh muscle size or concentric strength alone does not necessarily correspond to improved functional performance or dynamic lower-extremity stability after sports injury (Losciale *et al.*, 2026).

The patient may also have experienced arthrogenic muscle inhibition (AMI) following ACL injury, with quadriceps weakness and greater hamstring activation as a compensatory mechanism to limit excessive anterior tibial translation. AMI can cause an extension deficit in the injured knee and may increase the risk of quadriceps atrophy. Discontinuation of strengthening exercises in 2023, combined with continued recreational soccer twice a month, may have contributed to substantial biomechanical dysfunction. Postural assessment and gait analysis showed a pathological kinetic-chain pattern, including anterior pelvic tilt (APT), a protruding abdomen, internal pelvic rotation, genu varum, and toe-out, particularly on the right. Right hip abductor weakness and stiffness, supported by a positive Trendelenburg sign, may contribute to dynamic genu varum and toe-out during walking and other activities. Genu varum may also be associated with extensive medial meniscal damage and narrowing of the medial joint compartment.

Chronic ACL deficiency has been shown *in vivo* to alter joint kinematics in the frontal and sagittal planes, change the mechanical load-bearing axis, and cause abnormal translational and rotational movement of the tibia relative to the femur during weight-bearing

activities (Agostinone *et al.*, 2021; Murrell-Smith *et al.*, 2025). Such abnormal mechanical loading—particularly inappropriate patellofemoral contact forces during high-demand physical activities such as soccer—may substantially increase the risk of cartilage lesion progression, by as much as 1.55-fold (Schache *et al.*, 2023). Toe-out and genu varum may concentrate mechanical stress on particular compartments, potentially aggravating medial and lateral meniscal tears, as suggested by the positive anterior drawer, Lachman, Apley grind, McMurray, and Thessaly tests.

The patient's decision to discontinue strengthening exercises in 2023 was a critical point in the course of the injury. Evidence from RCTs indicates no significant difference in long-term OA risk between patients undergoing ACLR and those receiving nonoperative management (Cuzzolin *et al.*, 2021; Ridha *et al.*, 2025). However, both approaches require comprehensive, continuous, and closely supervised neuromuscular rehabilitation to restore dynamic joint stability. (Cuzzolin *et al.*, 2021; Murrell-Smith *et al.*, 2025) In cases of chronic instability managed nonoperatively without adequate rehabilitation, pivoting and jumping activities in soccer may act as repetitive microtrauma. Persistent mechanical instability may exceed the joint's capacity to compensate, potentially leading to more extensive secondary meniscal tears and accelerating articular cartilage deterioration toward the tidemark and subchondral bone sclerosis.

Without structured rehabilitation to correct biomechanical malalignment, reduce body weight,⁷ and modify sports activities, the patient may be at risk of progressive PTOA. Short-term consequences, including chronic pain, limited ROM such as an extension deficit, and reduced physical performance, may persist. (Harkey *et al.*, 2024; Losciale *et al.*, 2026). In the long term, the combination of chronic mechanical instability, meniscal damage, and obesity-related metabolic factors may increase the risk of permanent joint damage (Hollis *et al.*, 2023; Solanki *et al.*, 2023)

CONCLUSION

The patient in this clinical scenario has post-traumatic osteoarthritis (PTOA), or early secondary osteoarthritis, of the right knee associated with ACL and meniscal injuries and persistent instability. Lower-extremity kinetic-chain malalignment and hip abductor weakness may contribute to dynamic genu varum and toe-out, concentrating mechanical stress on the injured knee during movement. Obesity adds mechanical compression to the joint and may also promote low-grade systemic inflammation, accelerating cartilage damage. Discontinuation of strengthening exercises, combined with continued high-impact sport involving frequent pivoting, such as soccer, may aggravate repetitive microtrauma and impair knee function. Mild crepitus in the uninjured knee may indicate compensatory, uneven weight-bearing resulting from injury to the opposite side.

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