Recalibrating anterior cruciate ligament reconstruction rehabilitation: integrating mechanistic evidence, criterion-driven progression, and risk-informed return-to-sport decisions: a narrative review

Roman Carothers[1], Anthony T. Drazick[2], Phillip Page[3], Paxton Cook[1], Bryce Hargis[1], Jeremy M. Burnham[2]

[1]Ochsner Therapy and Wellness, New Orleans, LA, USA; [2]Ochsner-Andrews Sports Medicine Institute, Baton Rouge, LA, USA; [3]Franciscan Missionaries of Our Lady University, Baton Rouge, LA, USA

Contributions: (I) Conception and design: R Carothers, JM Burnham, P Page; (II) Administrative support: R Carothers, AT Drazick, JM Burnham; (III) Provision of study materials or patients: R Carothers, AT Drazick; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: R Carothers, P Cook, B Hargis, P Page; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Anthony T. Drazick, MD. Ochsner-Andrews Sports Medicine Institute, 5444 Burbank Dr., Baton Rouge, LA 70810, USA. Email: Anthony.drazick@ochsner.org.

Background and Objective: Rehabilitation after anterior cruciate ligament reconstruction (ACLR) remains variable, and persistent impairment and second-injury risk remain common. This narrative review asks four linked questions: how early impairments should be assessed and managed; how quadriceps recovery and loading should progress; which criteria should guide phase advancement; and how physical, psychological, neurocognitive, and contextual factors should be integrated into return-to-sport decisions.

Methods: PubMed (including MEDLINE), selected guideline repositories, and reference lists were searched from database inception through September 2, 2026. Contemporary clinical practice guidelines, systematic reviews, randomized and controlled trials, cohort studies, consensus statements, and foundational mechanistic reports were prioritized. This was a targeted narrative synthesis, not a systematic review or meta-analysis.

Key Content and Findings: Early decisions should integrate symptoms, effusion, motion, gait, quadriceps neuromuscular function, and the immediate and 24-hour response to loading. Neuromuscular electrical stimulation (NMES) and progressive resistance exercise have the clearest clinical roles; cryotherapy, surface electromyographic (sEMG) biofeedback, blood-flow restriction (BFR), and neurocognitive strategies are conditional adjuncts whose value depends on patient response and evidence limitations. Strength, task performance, movement strategy, patient-reported knee function, and psychological readiness should be assessed serially. Graft type and concomitant procedures modify loading tolerance and interpretation but do not justify universal graft-specific timelines. Return to sport (RTS) is a continuum from participation to sport to performance and requires stage-matched exposure and shared risk decisions.

Conclusions: Criterion-driven ACLR rehabilitation is best understood as repeated decision-making within biological, procedural, and contextual constraints. Numerical thresholds can inform decisions, but they should not function as stand-alone clearance rules when evidence is heterogeneous or population specific.

Keywords: Anterior cruciate ligament reconstruction (ACLR); rehabilitation; criterion-based progression; psychological readiness; return to sport (RTS)

Received: 30 May 2026; Accepted: 22 September 2026; Published online: 26 October 2026.

doi: 10.21037/aoj-2026-0034

View this article at: https://dx.doi.org/10.21037/aoj-2026-0034

© AME Publishing Company.

Introduction

Anterior cruciate ligament reconstruction (ACLR) is common, yet surgery does not by itself restore normal function. Persistent quadriceps deficits, altered loading strategies, reduced confidence, and second injury remain clinically important after reconstruction (1,2). Rehabilitation must therefore address recovery of capacity and the athlete's ability to express that capacity in progressively less controlled environments.

Clinical practice guidelines support criterion-based rehabilitation and repeated assessment rather than progression by time alone (3,4). Existing guidance, however, does not eliminate the day-to-day problem of deciding what to assess, which intervention is reasonable, how to interpret the response, and when uncertainty should slow progression. This review contributes a decision framework that links mechanistic rationale, serial patient-reported and objective findings, graft and concomitant-procedure constraints, phase-specific criteria, and risk tolerance. It is not intended as a universal protocol.

Accordingly, we address four questions: (I) which early impairments should be prioritized, and how should response be measured? (II) How should quadriceps recovery and progressive loading be dosed and advanced? (III) Which criteria should guide progression through rehabilitation? (IV) How should physical, psychological, neurocognitive, and contextual factors be integrated into return to sport (RTS)? Return-to-sport decisions should center the athlete and be shared with the surgeon, physical therapist, and athletic trainer, with parents or guardians, coaches, and team medical staff involved when age, setting, or sport context makes their input relevant. We present this article in accordance with the Narrative Review reporting checklist (available at https://aoj.amegroups.com/article/view/10.21037/aoj-2026-0034/rc).

Methods

A targeted narrative literature review was undertaken to synthesize evidence relevant to postoperative ACLR rehabilitation and RTS decision-making. PubMed (including MEDLINE), selected clinical guideline repositories, and reference lists of relevant reviews, guidelines, and consensus statements were searched from database inception through September 2, 2026. Search concepts combined anterior cruciate ligament (ACL) reconstruction with rehabilitation, criterion-based progression, pain, effusion, range of motion, arthrogenic muscle inhibition (AMI), quadriceps recovery, neuromuscular electrical stimulation (NMES), biofeedback, eccentric exercise, blood-flow restriction (BFR), open kinetic-chain exercise, strength and performance testing, patient-reported outcomes, psychological readiness, neurocognitive rehabilitation, graft type, concomitant procedures, RTS, and reinjury.

English-language human studies directly informing postoperative ACLR rehabilitation or RTS were eligible. Clinical practice guidelines, systematic and scoping reviews, randomized or controlled studies, cohort studies, consensus statements, and foundational mechanistic reports were prioritized. Non-English reports, duplicate or superseded publications, reports without direct ACLR relevance, and opinion statements without an identifiable evidence base were excluded. Because the review was designed to answer focused clinical questions rather than identify every eligible record or estimate pooled effects, a formal systematic-review flow diagram and risk-of-bias assessment were not performed. *Table 1* documents the search and selection approach.

© AME Publishing Company.

Table 1 Search strategy summary

Items	Specification
Date of search	May 1, 2026
Databases and other sources searched	PubMed (including MEDLINE); selected clinical guideline repositories; and reference lists of relevant reviews, guidelines, and consensus statements
Search terms used	MeSH and free-text concept blocks combined anterior cruciate ligament reconstruction with rehabilitation, criterion-based progression, pain, effusion, range of motion, arthrogenic muscle inhibition, quadriceps recovery, neuromuscular electrical stimulation, biofeedback, eccentric exercise, blood-flow restriction, open kinetic-chain exercise, strength and performance testing, patient-reported outcomes, psychological readiness, neurocognitive rehabilitation, graft type, concomitant procedures, return to sport, and reinjury. English-language and human-study filters were applied. See Table S1 for the detailed PubMed example
Timeframe	Database inception through September 2, 2026
Inclusion and exclusion criteria	Inclusion criteria: English-language human studies directly informing postoperative ACLR rehabilitation or return-to-sport decision-making; clinical practice guidelines, systematic and scoping reviews, randomized or controlled studies, cohort studies, consensus statements, and foundational mechanistic reports
	Exclusion criteria: non-English reports; duplicate or superseded publications; reports without direct ACLR relevance; and opinion statements without an identifiable evidence base
Selection process	The author team conducted a targeted narrative selection based on relevance, methodological strength, clinical applicability, and contribution to one of the four review questions. Formal independent duplicate screening was not performed. Differences regarding relevance or interpretation were resolved through discussion and author consensus
Additional considerations	Graft type, donor-site symptoms, concomitant meniscal or cartilage procedures, age, and sport context were treated as clinical modifiers. Evidence support was categorized descriptively as stronger, moderate, or limited/emerging; no formal risk-of-bias tool or certainty-grading framework was applied

ACLR, anterior cruciate ligament reconstruction.

Graft type and concomitant procedures were treated as clinical modifiers during synthesis. Evidence was examined, when reported, for quadriceps tendon, bone-patellar tendon-bone, hamstring tendon, and allograft reconstruction, and for meniscal or cartilage procedures. Because subgroup reporting was inconsistent and few studies directly compared rehabilitation strategies by graft or procedure, these factors are presented as modifiers of loading, testing, and expected recovery rather than as fixed timelines.

Evidence support was described pragmatically as stronger, moderate, or limited/emerging. Stronger support required concordant contemporary guidance or systematic review evidence with consistent clinical findings; moderate support reflected generally consistent comparative or cohort evidence with meaningful heterogeneity or indirectness; limited/emerging support reflected small studies, mechanistic work, early reliability evidence, clinical commentary, or expert practice. These labels are descriptive and are not a formal GRADE assessment. Recommendation language follows the same logic: recommend for better-supported actions, consider for conditional use, and may for emerging strategies. Artificial intelligence (AI)-assisted language editing and structural organization were used during revision as described in Acknowledgments; no AI tool generated study data or performed statistical analysis.

© AME Publishing Company.

Evidence synthesis and criterion-driven clinical framework

Question 1: which early impairments should be prioritized, and how should response be measured?

Early rehabilitation is a sequence of linked decisions rather than a fixed six-week phase. The recurring inputs are pain, swelling or stiffness, perceived function, confidence, adherence, effusion, passive and active motion, gait, quadriceps neuromuscular function, wound status, and response during the session and over the following 24 hours. A change in either objective capacity or patient-reported response may justify holding, advancing, or modifying the dose. Restrictions related to meniscal repair, cartilage restoration, osteotomy, multiligament injury, or surgeon-defined graft protection take precedence over a generic timeline.

Pain and effusion

Pain and effusion can limit motion, weight-bearing tolerance, and quadriceps activation, but no single bedside measure is a direct surrogate for AMI (5-8). A standardized sweep or stroke test provides a practical ordinal estimate. Circumferential measurement can supplement it when landmarks, limb position, and time of day are standardized, but the conversion of circumference to intra-articular fluid volume should not be assumed (9). Serial interpretation should include the patient's report of swelling and stiffness, pain behavior, medication use, gait, and the 24-hour response to loading.

Recommendation: use the same effusion method across visits and interpret it with symptoms and function. Escalating effusion, loss of previously achieved motion, fever, wound change, disproportionate pain, or calf symptoms warrants medical review rather than simply reducing exercise.

Cryotherapy as an adjunct

Cryotherapy may reduce short-term pain and, when combined with compression, may assist symptom control. It can also transiently improve quadriceps activation in some patients, but evidence does not establish a durable strength effect or a universal treatment window (4,10-15). Cryotherapy should not replace progressive loading, and skin sensation, vascular status, wound protection, tolerance, and patient preference should guide use.

Recommendation: consider 10–20 minutes of protected local cooling, with or without compression, for short-term symptom relief or immediately before quadriceps practice when the patient demonstrates a favorable response. Stop if skin injury, excessive discomfort, or adverse symptoms occur.

Restoring passive extension

Loss of extension can alter joint mechanics, perpetuate quadriceps inhibition, and contribute to poor gait (16-18). Measurement should be standardized because both intra-rater and inter-rater error vary with examiner experience, landmark selection, and positioning (19,20). When extension is limited, first confirm the measurement and compare it with the contralateral limb and, when available, the preinjury baseline. Next assess irritability and effusion, patellofemoral and anterior-interval mobility, hamstring guarding, and symptoms suggesting a mechanical block or postoperative complication.

The prone passive lag test can supplement goniometry when a passive extension difference is suspected, but guarding and table position can affect the result (21). *Figure 1* depicts a standardized supine comparison and *Figure 2* depicts the prone test.

© AME Publishing Company.



Figure 1 Supine assessment of passive knee extension. The patient lies supine with the distal femur supported and the knee relaxed. The examiner stabilizes the distal femur and supports the heel to compare passive extension with the contralateral limb. Standardize landmarks and position; guarding and irritability can affect the result.

The clinical goal is symmetrical passive extension, including the patient's physiological hyperextension when present, rather than universal hyperextension.



Figure 2 Prone passive lag test. With the patella just beyond the edge of the plinth, the heel-to-floor distance is compared between limbs. The test can supplement goniometry when a passive extension deficit is suspected. Hamstring guarding, discomfort, and table position should be recorded.

© AME Publishing Company.



Figure 3 Representative patellar-mobility assessment. The clinician stabilizes the femur and applies a controlled patellar glide in the direction being assessed, comparing excursion and symptom response with the contralateral knee. Mobilization is indicated only when a reproducible restriction is present and the response is favorable.

Patellofemoral mobility and sustained end-range loading

Patellar or anterior-interval restriction should be assessed before sustained stretching, particularly when anterior pain, graft harvest, or local fibrosis may affect the extensor mechanism (22-24). (*Figure 3*) Mobilization can be used when a reproducible restriction is present and the response is favorable; neither universal multidirectional treatment nor a fixed five-times-daily dose is supported.

Low-load, long-duration stretching may be considered when a persistent extension deficit remains after arthrokinematic restriction, marked guarding, and a possible mechanical block have been addressed (3,25,26). Position and dose should permit relaxation without neural symptoms, anterior impingement, or compensatory rotation. *Figures 4*,*5* contrast a position that may increase neural tension and guarding with a supported position. Multiple tolerable bouts may be accumulated across the day and adjusted to the immediate and 24-hour response; current evidence does not justify a universal prescription of 10 minutes eight to ten times daily.

Flexion and gait

Flexion usually progresses more gradually than extension and is influenced by effusion, pain, wound status, graft harvest, and concomitant procedures. A time point can provide biological context, but motion should be advanced according to tissue constraints and response. Weight-bearing and assistive-device progression should likewise be based

© AME Publishing Company.



Figure 4 Heel-prop position that may increase neural tension and guarding. Marked hip flexion and forward trunk flexion can resemble a slump position and make relaxation difficult. The device position and patient behavior should be adjusted if neural symptoms, posterior discomfort, or compensatory rotation occur.

on the surgical plan, adequate quadriceps control, knee motion during stance, step symmetry, balance, and absence of a clinically important symptom flare (27-29).

Answer to question 1: reassess symptoms, effusion, motion, gait, and quadriceps neuromuscular function together. Address the dominant impairment in a defensible order, document the load response, and escalate unexpected or persistent loss of motion rather than treating it as a routine flexibility problem.

Question 2: how should quadriceps recovery and progressive loading be dosed and advanced?

AMI reflects peripheral and central changes that can limit voluntary quadriceps activation after ACL injury and reconstruction (11,30-32). Early management should reduce modifiable irritants and create repeated opportunities for high-quality contraction. The treatment target should evolve from visible activation and active knee control to progressively higher force, hypertrophy, rate of torque development, and task-specific force expression.

NMES

NMES can improve early quadriceps activation and strength, particularly when voluntary recruitment is poor and the stimulus produces a strong, tolerable contraction (11,33-35). Passive and superimposed NMES protocols should not be treated as interchangeable, and superimposed stimulation has not consistently shown superiority across populations (36). *Table 2* separates preparation and positioning from prescription parameters. *Figure 6* demonstrates one objective setup; it is not a universal device configuration.

© AME Publishing Company.



Figure 5 Supported heel-prop position for tolerable end-range loading. The trunk and hip are supported, the posterior knee remains unobstructed, and the limb is positioned to permit relaxation. An optional load may be placed proximal to the patella only when it is well tolerated and does not cause anterior impingement, neural symptoms, or compensation.

© AME Publishing Company.

Table 2 Practical NMES application after ACLR

Domain	Clinical application
Preparation	Screen skin and sensation; explain expected contraction; use adequately sized electrodes over motor points; protect the surgical site
Position	Use a stable knee angle, commonly near 60 degrees of flexion when tolerated, and secure the limb so force can be expressed safely
Frequency and pulse duration	Commonly 50–75 pulses/s and approximately 250–400 microseconds; adjust to device capability, comfort, and contraction quality
Duty cycle	Approximately 10–15 seconds on with 40–60 seconds off; include a short ramp as needed
Intensity target	Increase to the strongest tolerable contraction. When force testing is feasible, an objective target such as at least 50% of maximal voluntary isometric contraction may guide progression, but should not delay useful treatment when testing is unsafe
Dose and progression	Accumulate approximately 10–15 high-quality contractions. Reassess active knee control, force, symptoms, and the 24-hour response; progress intensity and voluntary contribution before adding task complexity
Cautions	Follow device and medical contraindications; stop for skin injury, unexpected pain, autonomic symptoms, or loss of safe positioning

ACLR, anterior cruciate ligament reconstruction; NMES, neuromuscular electrical stimulation.



Figure 6 NMES application with an objective contraction target. Large electrodes are positioned over quadriceps motor points, the knee is stabilized at a tolerable flexion angle, and a dynamometer may be used to quantify evoked force. Intensity is progressed to the strongest tolerable contraction within device and medical precautions; this image illustrates one setup rather than a universal prescription. NMES, neuromuscular electrical stimulation.

© AME Publishing Company.

Surface electromyographic (sEMG) biofeedback and eccentric exercise

sEMG biofeedback records electrical activity detected over the muscle and provides real-time feedback during contraction or movement. It does not directly measure cortical activation or central nervous system drive. Evidence suggests possible improvements in quadriceps recruitment or movement strategy, but protocols and outcomes are heterogeneous (37,38). sEMG may be most useful when the feedback changes effort or visible unloading and should be discontinued when it no longer adds value.

Eccentric loading can support hypertrophy, strength, and neuromuscular recovery when the graft, donor site, range, and irritability permit (39,40-42). In the Lepley studies, eccentric training began at approximately six weeks and was performed twice weekly for six weeks; the eccentric and NMES conditions used different setups and were not equivalent head-to-head doses. Progress load or range only when technique is controlled and pain, effusion, and the 24-hour response remain acceptable.

BFR training

BFR training may help expose muscle to a hypertrophic stimulus when symptoms, tissue constraints, or load intolerance limit conventional higher-load resistance exercise. Low-load protocols commonly use approximately 20–40% of one-repetition maximum with individualized limb occlusion pressure. Meta-analytic findings suggest possible benefits for selected strength, pain, or patient-reported outcomes, but heterogeneity is substantial (43). Two well-designed trials temper categorical claims: Curran et al. found no added benefit when 80% limb occlusion pressure was combined with 70% one-repetition-maximum leg press beginning 10 weeks after surgery, and Erickson et al. found no added benefit of active low-load BFR over a sham-controlled standard program for strength, morphology, physiology, or gait biomechanics (44,45).

Recommendation: consider BFR as an adjunct when conventional loading is not yet tolerated or when a patient-specific reason supports its use. Use individualized occlusion pressure, a low external load, appropriate screening, and close monitoring. Do not present BFR as routinely superior to a well-designed standard program; cost, discomfort, contraindications, preference, and the ability to progress conventional loading matter.

Open kinetic-chain loading and graft modifiers

Open kinetic-chain knee extension provides a direct way to load the quadriceps and can reduce compensation by other joints. Evidence supports graded introduction rather than blanket avoidance, with range, load, and timing matched to graft biology, anterior-knee symptoms, and the surgical plan (46,47). Hip position can change rectus femoris hypertrophy during leg extension, but this finding should not be converted into a graft-specific prescription (48).

Graft type modifies the expected deficit: quadriceps tendon and bone-patellar tendon-bone harvest may be accompanied by extensor weakness or anterior-knee symptoms, whereas hamstring harvest may influence flexor strength. These group patterns should focus assessment and exercise selection, not impose fixed timelines. Contemporary reviews report broadly similar clinical outcomes across common autografts while emphasizing donor-site differences, heterogeneous strength recovery, and inconsistent RTS definitions (49-51). When morphology is discussed, the cross-sectional area of the harvested tendon graft and the cross-sectional area of quadriceps muscle must be identified separately because they are not interchangeable constructs.

© AME Publishing Company.

Answer to question 2: establish a tolerable contraction, add NMES when recruitment is limited, and progress resistance through range and task according to measured force and load response. Use cryotherapy, sEMG, BFR, and other adjuncts conditionally. Graft and procedure factors refine the plan, but patient response determines the dose.

Question 3: which criteria should guide progression through rehabilitation?

Repeated strength and performance assessment

Strength testing should begin when the result can change management and continue across rehabilitation. Isokinetic dynamometry offers controlled testing across velocities; fixed-frame or validated handheld/load-cell dynamometry can improve access, although agreement and limb-symmetry estimates may differ by method (52-55). Serial testing should use the same device, joint angle, stabilization, warm-up, instructions, and normalization approach whenever possible.

Limb symmetry index (LSI) is useful but can overestimate recovery when both limbs are weak or the uninvolved limb changes during rehabilitation (56,57). Absolute or body-mass-normalized strength, rate of torque development, task performance, and movement strategy should complement LSI. Values reported for return to running or sport are decision aids derived from specific populations and protocols, not universal clearance standards (53,58,59).

Phase advancement as a load-response decision

Table 3 summarizes a sequence of clinical prerequisites. Time remains relevant because tissue healing and procedure restrictions cannot be bypassed, but it is not the first or sole criterion. Patient-reported outcome measures (PROMs) refer to reports of symptoms, function, and quality of life; passive range of motion is written out because PROM is reserved for PROM.

© AME Publishing Company.

Table 3 Criterion-driven progression across rehabilitation

Decision stage	Assessment inputs	Progression signal	Modifiers and evidence support
Early protection and mobility	Symptoms; wound; effusion; passive extension; flexion; gait; active knee control	Stable or improving symptoms; no important 24-hour flare; extension approaching baseline; safe gait within restrictions	Meniscal, cartilage, multi-ligament restrictions, and surgeon plan take priority. Stronger support for symptom, motion, gait, and quadriceps monitoring
Progressive strengthening	Quadriceps and hamstring force; donor-site symptoms; exercise technique; effusion; PROM trend	Tolerates higher load or range with controlled technique and stable next-day response	Graft harvest may shift the dominant deficit. Moderate support; dose-response evidence remains heterogeneous
Running preparation	Effusion; full or near-full motion; normalized gait; quadriceps capacity; repeated single-limb tasks; running-load tolerance	Low irritability; adequate force and task control for graded running; no deterioration after exposure	Thresholds vary by test and population. Moderate support; time supplies biological context
Plyometric and change-of-direction progression	Landing/deceleration strategy; force/power; asymmetry; fatigue response; confidence; cognitive-motor demand	Controls planned tasks before unplanned tasks; tolerates progressive volume, speed, and uncertainty	Sport and surface change external load. Moderate to limited support for specific cutoffs
Return to participation	Training exposure; symptoms; strength; task performance; psychological readiness	Completes defined modified practice dose with stable response	Role and contact restrictions must be explicit. Moderate support
Return to sport	Sport-specific exposure; multidomain testing; PROMs; confidence/fear; shared risk review	Resumes the defined sport at an agreed level with monitored load	No single battery eliminates reinjury risk. Moderate support; thresholds are context dependent
Return to performance	Competition load; repeat-bout capacity; performance metrics; recovery; athlete-defined goals	Sustains or exceeds intended performance with acceptable recovery and risk	Evidence is limited and sport specific

Evidence-support terms are descriptive and do not constitute a formal GRADE assessment. GRADE, Grading of Recommendations Assessment, Development and Evaluation; PROM, patient-reported outcome measure.

Kinetic-chain and neurocognitive progression

Hip and calf deficits are not universal after ACLR, but selective impairments can affect force distribution and task strategy (60-62). Assess and train the kinetic chain according to the individual task rather than assuming that every athlete requires the same proximal program. Cognitive-motor demands can be added by manipulating visual information, decision time, divided attention, or unpredictability after the underlying task is safe. Neuroimaging and dual-task studies support the concept of altered visual-motor control, but specific rehabilitation doses and clearance thresholds remain emerging (32,63-65).

Answer to question 3: advance phases when the athlete demonstrates sufficient capacity for the next exposure and maintains an acceptable symptom and effusion response. Use repeated, standardized measures; interpret symmetry with absolute capacity and movement strategy; and match the test ceiling to the demands being introduced.

© AME Publishing Company.

Question 4: how should the return-to-sport continuum be assessed and shared?

Define the decision before selecting the test

RTS is a continuum, not a single clearance event. Return to participation means the athlete is active in rehabilitation, modified training, or sport below the intended competitive level. RTS means the athlete has resumed the defined sport but may not yet have regained the desired performance level. Return to performance means the athlete has regained or exceeded that level (66). A criterion that is adequate for modified practice does not automatically authorize unrestricted competition. *Table 4* links each stage to exposure, assessment, and decision responsibility.

Table 4 Stage-matched return-to-sport continuum

Stage	Exposure	Assessment emphasis	Shared decision and documentation
Return to participation	Rehabilitation, modified practice, controlled drills, restricted role	Symptoms; training-load response; foundational strength and task control; confidence	Athlete, rehabilitation team, surgeon when procedure status matters, and coach for role restrictions define what is permitted, prohibited, and monitored
Return to sport	Full or near-full practice and resumption of the defined sport	Absolute and relative strength; power; movement strategy; repeated sport-specific exposure; PROMs and psychological readiness	The athlete and clinical team, with family/guardian and team staff when relevant, document accepted residual risks and the load-progression plan
Return to performance	Target competition role and performance demands	Repeat-bout capacity; sport metrics; fatigue response; recovery; athlete-defined performance goals	The athlete, clinical team, performance staff, and coach confirm that performance and recovery are sustainable, not merely that participation occurred

PROMs, patient-reported outcome measures.

Physical testing and movement strategy

Time alone remains common in RTS decisions despite known limitations (67). Testing should sample the capacities required for the contemplated stage: quadriceps and hamstring strength, power, landing and deceleration, speed, agility, conditioning, and repeated exposure. LSI and body-mass-normalized strength are complementary. Horizontal hop distance can mask reduced knee contribution, whereas vertical tasks may expose knee extensor limitations more directly; neither distance nor height alone captures landing strategy (68,69).

Repeated testing is preferable to a final pass-fail event. The athlete should first demonstrate control in planned tasks, then tolerate increased speed, volume, fatigue, contact, and uncertainty. Failing a component should lead to a targeted treatment decision, not merely repetition of the same test. No battery can guarantee reinjury prevention.

PROMs and psychological readiness

Knee-specific PROMs and psychological readiness should be assessed throughout rehabilitation, not added only at final clearance. The International Knee Documentation Committee subjective form or Knee injury and Osteoarthritis Outcome Score can follow symptoms, function, and knee-related quality of life. The ACL-Return to Sport after Injury scale (ACL-RSI) addresses emotions, confidence, and risk

© AME Publishing Company.

appraisal; the Tampa Scale of Kinesiophobia or Knee Self-Efficacy Scale can clarify fear and self-efficacy. Athletes who RTS generally report higher psychological readiness, but association does not establish a universal cutoff or prove that changing a score will change reinjury risk (70-72).

Serial trends and discordance are clinically useful. An athlete with strong physical tests but persistent fear may need graded exposure, clearer education, collaborative goal setting, and, when distress or avoidance exceeds rehabilitation scope, referral to a qualified sport-psychology or mental-health professional. An athlete with high confidence but incomplete physical capacity requires an equally explicit plan. No single PROM should determine clearance.

Neurocognitive demand and shared risk

Reactive and dual-task tests may reveal performance costs not apparent in planned tasks, but no validated dual-task-cost threshold has been established for clearance (65). Such measures may be used for within-athlete monitoring when reliability is acceptable, with the result interpreted as emerging evidence rather than a pass-fail standard.

Shared decision-making should make the decision, residual uncertainty, and authority explicit. The athlete is central. The surgeon informs tissue and procedure constraints; the physical therapist and athletic trainer synthesize capacity, symptoms, exposure, and response; coaches and performance staff define sport demands; and parents or guardians participate when age or context requires. The Strategic Assessment of Risk and Risk Tolerance framework separates tissue health, expected tissue stress, and modifiers of acceptable risk (66). Earlier return has been associated with greater second-injury risk in young athletes, but newer cohort findings also show the importance of meeting objective criteria and the limits of transporting time thresholds across populations (73-76).

Late-stage neuromuscular and exercise-based prevention should continue after the athlete resumes sport. The 2023 Arundale guideline is scientifically appropriate for this phase because it addresses exercise-based knee and ACL injury prevention; it is not a comprehensive postoperative rehabilitation guideline (77).

Answer to question 4: define the RTS stage, match testing and exposure to that stage, integrate physical performance with PROMs and psychological readiness, and document the athlete-centered risk decision. Clearance is a managed transition, not a certificate that risk is absent.

Strengths and limitations of the review

The principal strength of this review is the integration of assessment, intervention choice, load response, graft and procedure modifiers, psychological readiness, and risk tolerance in the same clinical framework. It extends the 2023 Aspetar postoperative guideline by emphasizing repeated decision logic and complements the Arundale prevention guideline by connecting late-stage prevention with the full postoperative continuum (4,77). Conflicting BFR trials, uncertainty in psychological cutoffs, and inconsistent graft-specific RTS definitions are presented directly rather than treated as noise.

This targeted narrative review also has important limitations. It was not a systematic review, did not use duplicate screening, and did not apply a formal risk-of-bias or certainty framework. English-language restriction may have excluded relevant

© AME Publishing Company.

evidence. Interventions, grafts, concomitant procedures, testing protocols, populations, and outcome definitions were heterogeneous; several recommendations therefore rely on indirect evidence or expert clinical reasoning. The descriptive evidence-support categories should not be interpreted as formal grades. Prospective validation is needed for multidomain progression algorithms, graft- and population-specific thresholds, psychological interventions, cognitive-motor testing, and implementation across settings.

Conclusions

Rehabilitation after ACLR is best managed as a series of criterion-driven decisions within biological and procedural constraints. Early progression should integrate serial symptoms, effusion, motion, gait, and quadriceps neuromuscular function; loading should advance according to measured capacity and response; phase advancement should combine strength, task performance, movement strategy, and patient-reported function; and RTS should be treated as a continuum that includes psychological readiness, cognitive-motor demands, sport exposure, and shared risk tolerance. Numerical thresholds can inform these decisions, but heterogeneous evidence and graft- and population-specific recovery preclude their use as universal clearance standards.

Acknowledgments

OpenAI Codex (GPT-5-based model; OpenAI, San Francisco, CA, USA) was used on September 2, 2026 to assist with grammar checking. The authors are responsible for independently verifying every statement, citation, interpretation, and submitted file.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Annals of Joint* for the series "Evaluation and Treatment of ACL Injuries in High Level Athletes: The Continuum of Care". The article has undergone external peer review.

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://aoj.amegroups.com/article/view/10.21037/aoj-2026-0034/rc

Peer Review File: Available at https://aoj.amegroups.com/article/view/10.21037/aoj-2026-0034/prf

Funding: None.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://aoj.amegroups.com/article/view/10.21037/aoj-2026-0034/coif). The series "Evaluation and Treatment of ACL Injuries in High Level Athletes: The Continuum of Care" was commissioned by the editorial office without any funding or sponsorship. J.M.B. served as the unpaid Guest Editor of the series. J.M.B. reports

© AME Publishing Company.

research funding from the American Orthopaedic Society for Sports Medicine, the U.S. Department of Defense (DoD), the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), and the Louisiana Orthopedic Society and he is a consultant of Arthrex, Inc. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Written informed consent for publication of the clinical images was obtained from all patients depicted in this manuscript.

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: https://creativecommons.org/licenses/by-nc-nd/4.0/.

References

1. Sanders TL, Maradit Kremers H, Bryan AJ, et al. Incidence of and Factors Associated With the Decision to Undergo Anterior Cruciate Ligament Reconstruction 1 to 10 Years After Injury. Am J Sports Med 2016;44:1558-64.
2. Graham MC, Reeves KA, Johnson DL, et al. Relationship Between Quadriceps Strength and Knee Joint Power During Jumping After ACLR. Orthop J Sports Med 2023;11:23259671231150938.
3. Adams D, Logerstedt DS, Hunter-Giordano A, et al. Current concepts for anterior cruciate ligament reconstruction: a criterion-based rehabilitation progression. J Orthop Sports Phys Ther 2012;42:601-14.
4. Kotsifaki R, Korakakis V, King E, et al. Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction. Br J Sports Med 2023;57:500-14.
5. Hart JM, Pietrosimone B, Hertel J, et al. Quadriceps activation following knee injuries: a systematic review. J Athl Train 2010;45:87-97.
6. Hopkins JT, Ingersoll CD, Krause BA, et al. Effect of knee joint effusion on quadriceps and soleus motoneuron pool excitability. Med Sci Sports Exerc 2001;33:123-6.
7. Johnson AK, McCollin T, Garcia SA, et al. The relationship between knee joint effusion and quadriceps strength and activation after anterior cruciate ligament (ACL) injury and reconstruction. J Athl Train 2024. [Epub ahead of print]. doi: 10.4085/1062-6050-0294.24.
8. Lynch AD, Logerstedt DS, Axe MJ, et al. Quadriceps activation failure after anterior cruciate ligament rupture is not mediated by knee joint effusion. J Orthop Sports Phys Ther 2012;42:502-10.
9. Kirwan JR, Byron MA, Winfield J, et al. Circumferential measurements in the assessment of synovitis of the knee. Rheumatol Rehabil 1979;18:78-84.

10. Waterman B, Walker JJ, Swaims C, et al. The efficacy of combined cryotherapy and compression compared with cryotherapy alone following anterior cruciate ligament reconstruction. J Knee Surg 2012;25:155-60.
11. Sonnery-Cottet B, Saithna A, Quelard B, et al. Arthrogenic muscle inhibition after ACL reconstruction: a scoping review of the efficacy of interventions. Br J Sports Med 2019;53:289-98. Erratum in: Br J Sports Med. 2019 Dec;53(23):e8.
12. Hart JM, Kuenze CM, Diduch DR, et al. Quadriceps muscle function after rehabilitation with cryotherapy in patients with anterior cruciate ligament reconstruction. J Athl Train 2014;49:733-9.
13. Kuenze CM, Kelly AR, Jun HP, et al. Unilateral Quadriceps Strengthening With Disinhibitory Cryotherapy and Quadriceps Symmetry After Anterior Cruciate Ligament Reconstruction. J Athl Train 2017;52:1010-8.
14. Pietrosimone BG, Ingersoll CD. Focal knee joint cooling increases the quadriceps central activation ratio. J Sports Sci 2009;27:873-9.
15. Loro WA, Thelen MD, Rosenthal MD, et al. The effects of cryotherapy on quadriceps electromyographic activity and isometric strength in patient in the early phases following knee surgery. J Orthop Surg (Hong Kong) 2019;27:2309499019831454.
16. Mauro CS, Irrgang JJ, Williams BA, et al. Loss of extension following anterior cruciate ligament reconstruction: analysis of incidence and etiology using IKDC criteria. Arthroscopy 2008;24:146-53.
17. Noyes FR, Berrios-Torres S, Barber-Westin SD, et al. Prevention of permanent arthrofibrosis after anterior cruciate ligament reconstruction alone or combined with associated procedures: a prospective study in 443 knees. Knee Surg Sports Traumatol Arthrosc 2000;8:196-206.
18. Ahmad CS, Kwak SD, Ateshian GA, et al. Effects of patellar tendon adhesion to the anterior tibia on knee mechanics. Am J Sports Med 1998;26:715-24.
19. Akizuki K, Yamaguchi K, Morita Y, et al. The effect of proficiency level on measurement error of range of motion. J Phys Ther Sci 2016;28:2644-51.
20. Milanese S, Gordon S, Buettner P, et al. Reliability and concurrent validity of knee angle measurement: smart phone app versus universal goniometer used by experienced and novice clinicians. Man Ther 2014;19:569-74.
21. Deepak S, Priti G; DScPT, et al. The sitting active and prone passive lag test: a validity study in a symptomatic knee population. J Phys Ther Sci 2023;35:312-9.
22. Hart HF, Culvenor AG, Patterson BE, et al. Infrapatellar fat pad volume and Hoffa-synovitis after ACL reconstruction: Association with early osteoarthritis features and pain over 5 years. J Orthop Res 2022;40:260-7.
23. Nakagawa Y, Tsuji K, Nakamura T, et al. Association of Infrapatellar Fat Pad Fibrosis at 3 Months After ACL Reconstruction With Short-term Clinical Outcomes and Inflammatory Cytokine Levels in the Synovial Fluid. Orthop J Sports Med 2023;11:23259671231164122.
24. Manske RC, Davies GJ. EXAMINATION OF THE PATELLOFEMORAL JOINT. Int J Sports Phys Ther 2016;11:831-53.

© AME Publishing Company.

25. Aspinall SK, Bamber ZA, Hignett SM, et al. Medical stretching devices are effective in the treatment of knee arthrofibrosis: A systematic review. J Orthop Translat 2021;27:119-31.
26. Jacobs CA, Sciascia AD. Factors that influence the efficacy of stretching programs for patients with hypomobility. Sports Health 2011;3:520-3.
27. Cavanaugh JT, Powers M. ACL Rehabilitation Progression: Where Are We Now? Curr Rev Musculoskelet Med 2017;10:289-96.
28. Tyler TF, McHugh MP, Gleim GW, et al. The effect of immediate weightbearing after anterior cruciate ligament reconstruction. Clin Orthop Relat Res 1998(357):141-8.
29. Buckthorpe M, Tamisari A, Villa FD. A TEN TASK-BASED PROGRESSION IN REHABILITATION AFTER ACL RECONSTRUCTION: FROM POST-SURGERY TO RETURN TO PLAY - A CLINICAL COMMENTARY. Int J Sports Phys Ther 2020;15:611-23.
30. Solie B, Carlson M, Doney C, et al. Oh, My Quad: A Clinical Commentary And Evidence-Based Framework for the Rehabilitation of Quadriceps Size and Strength after Anterior Cruciate Ligament Reconstruction. Int J Sports Phys Ther 2024;19:1600-28.
31. Forelli F, Moiroux-Sahraoui A, Mazeas J, et al. Rethinking the Assessment of Arthrogenic Muscle Inhibition After ACL Reconstruction: Implications for Return-to-Sport Decision-Making-A Narrative Review. J Clin Med 2025;14:2633.
32. Grooms DR, Page SJ, Nichols-Larsen DS, et al. Neuroplasticity Associated With Anterior Cruciate Ligament Reconstruction. J Orthop Sports Phys Ther 2017;47:180-9.
33. Kim KM, Croy T, Hertel J, et al. Effects of neuromuscular electrical stimulation after anterior cruciate ligament reconstruction on quadriceps strength, function, and patient-oriented outcomes: a systematic review. J Orthop Sports Phys Ther 2010;40:383-91.
34. Snyder-Mackler L, Delitto A, Stralka SW, et al. Use of electrical stimulation to enhance recovery of quadriceps femoris muscle force production in patients following anterior cruciate ligament reconstruction. Phys Ther 1994;74:901-7.
35. Arhos EK, Ito N, Hunter-Giordano A, et al. Who's Afraid of Electrical Stimulation? Let's Revisit the Application of NMES at the Knee. J Orthop Sports Phys Ther 2024;54:101-6.
36. Borzuola R, Laudani L, Labanca L, et al. Superimposing neuromuscular electrical stimulation onto voluntary contractions to improve muscle strength and mass: A systematic review. Eur J Sport Sci 2023;23:1547-59.
37. Karaborklu Argut S, Celik D, Yasacı Z. Effectiveness of therapeutic electromyographic biofeedback after orthopedic knee surgeries: a systematic review. Disabil Rehabil 2022;44:3364-72.
38. Moiroux-Sahraoui A, Forelli F, Mazeas J, et al. Quadriceps Activation After Anterior Cruciate Ligament Reconstruction: The Early Bird Gets the Worm! Int J Sports Phys Ther 2024;19:1044-51.

© AME Publishing Company.

39. Gerber JP, Marcus RL, Dibble LE, et al. Safety, feasibility, and efficacy of negative work exercise via eccentric muscle activity following anterior cruciate ligament reconstruction. J Orthop Sports Phys Ther 2007;37:10-8.
40. Lepley LK, Wojtys EM, Palmieri-Smith RM. Combination of eccentric exercise and neuromuscular electrical stimulation to improve quadriceps function post-ACL reconstruction. Knee 2015;22:270-7.
41. Lepley LK, Wojtys EM, Palmieri-Smith RM. Combination of eccentric exercise and neuromuscular electrical stimulation to improve biomechanical limb symmetry after anterior cruciate ligament reconstruction. Clin Biomech (Bristol) 2015;30:738-47.
42. Lepley LK, Lepley AS, Onate JA, et al. Eccentric Exercise to Enhance Neuromuscular Control. Sports Health 2017;9:333-40.
43. Gopinatth V, Garcia JR, Reid IK, et al. Blood Flow Restriction Enhances Recovery After Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-analysis of Randomized Controlled Trials. Arthroscopy 2025;41:1048-60.
44. Curran MT, Bedi A, Mendias CL, et al. Blood Flow Restriction Training Applied With High-Intensity Exercise Does Not Improve Quadriceps Muscle Function After Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Trial. Am J Sports Med 2020;48:825-37.
45. Erickson LN, Owen MK, Casadonte KR, et al. The Efficacy of Blood Flow Restriction Training to Improve Quadriceps Muscle Function after Anterior Cruciate Ligament Reconstruction. Med Sci Sports Exerc 2025;57:227-37.
46. Noehren B, Snyder-Mackler L. Who's Afraid of the Big Bad Wolf? Open-Chain Exercises After Anterior Cruciate Ligament Reconstruction. J Orthop Sports Phys Ther 2020;50:473-5.
47. Beynnon BD, Johnson RJ, Fleming BC, et al. The strain behavior of the anterior cruciate ligament during squatting and active flexion-extension. A comparison of an open and a closed kinetic chain exercise. Am J Sports Med 1997;25:823-9.
48. Larsen S, Sandvik Kristiansen B, Swinton PA, et al. The effects of hip flexion angle on quadriceps femoris muscle hypertrophy in the leg extension exercise. J Sports Sci 2025;43:210-21.
49. Schwery NA, Kiely MT, Larson CM, et al. Quadriceps Strength following Anterior Cruciate Ligament Reconstruction: Normative Values based on Sex, Graft Type and Meniscal Status at 3, 6 & 9 Months. Int J Sports Phys Ther 2022;17:434-44.
50. White T, Castro M, Antonio L, et al. Quadriceps, hamstring and patella tendon autografts for primary anterior cruciate ligament reconstruction demonstrate similar clinical outcomes, including graft failure, joint laxity and complications: A systematic review with meta-analysis of randomised controlled trials. Knee Surg Sports Traumatol Arthrosc 2026;34:1631-46.
51. Emmert AS, Hale I, Lake LP, et al. Varying Definitions of Return to Sport, Study Quality, and Outcome Measurements Limit Comparison of Primary Anterior Cruciate Ligament Reconstruction With Quadriceps Tendon Autografts to Hamstring and Bone-Patellar Tendon-Bone Autografts: A Systematic Review. Arthroscopy 2025;41:4335-45.

© AME Publishing Company.

52. Giampetruzzi N, Weaver AP, Roman DP, et al. Which Tests Predict 6-Month Isokinetic Quadriceps Strength After ACL Reconstruction? An Examination of Isometric Quadriceps Strength and Functional Tests at 3 Months. Int J Sports Phys Ther 2023;18:1261-70.
53. van Melick N, van der Weegen W, van der Horst N. Quadriceps and Hamstrings Strength Reference Values for Athletes With and Without Anterior Cruciate Ligament Reconstruction Who Play Popular Pivoting Sports, Including Soccer, Basketball, and Handball: A Scoping Review. J Orthop Sports Phys Ther 2022;52:142-55.
54. Center JA, Willy RW, Elias ARC, et al. Validity of a commercially available load cell dynamometer in measuring isometric knee extension torque in patients with knee disorders. Phys Ther Sport 2024;67:167-73.
55. Ivarsson A, Cronström A. Agreement Between Isokinetic Dynamometer and Hand-held Isometric Dynamometer as Measures to Detect Lower Limb Asymmetry in Muscle Torque After Anterior Cruciate Ligament Reconstruction. Int J Sports Phys Ther 2022;17:1307-17.
56. Barbosa O, Kotsifaki R, Whiteley R, et al. Beware of the "Moving Target" - Uninvolved Limb Strength Increases to Exceed Preoperative Values During Rehabilitation After ACL Reconstruction in Male Professional and Recreational Athletes. J Orthop Sports Phys Ther 2024;54:258-66.
57. Wellsandt E, Failla MJ, Snyder-Mackler L. Limb Symmetry Indexes Can Overestimate Knee Function After Anterior Cruciate Ligament Injury. J Orthop Sports Phys Ther 2017;47:334-8.
58. Bodkin S, Bennion D, Pales-Taylor M, et al. Interpreting Quadriceps Strength Thresholds for Patients Following ACL-Reconstruction: A Clinical Commentary. Int J Sports Phys Ther 2025;20:1534-40.
59. Rambaud AJM, Ardern CL, Thoreux P, et al. Criteria for return to running after anterior cruciate ligament reconstruction: a scoping review. Br J Sports Med 2018;52:1437-44.
60. Maniar N, Schache AG, Sritharan P, et al. Non-knee-spanning muscles contribute to tibiofemoral shear as well as valgus and rotational joint reaction moments during unanticipated sidestep cutting. Sci Rep 2018;8:2501.
61. Bruce Leicht AS, Thompson XD, Kaur M, et al. Hip Strength Recovery After Anterior Cruciate Ligament Reconstruction. Orthop J Sports Med 2023;11:23259671231169196.
62. Girdwood M, Culvenor AG, Patterson B, et al. No sign of weakness: a systematic review and meta-analysis of hip and calf muscle strength after anterior cruciate ligament injury. Br J Sports Med 2024;58:500-10.
63. Miko SC, Simon JE, Monfort SM, et al. Postural stability during visual-based cognitive and motor dual-tasks after ACLR. J Sci Med Sport 2021;24:146-51. Erratum in: J Sci Med Sport. 2022 Jun;25(6):540.
64. Grooms D, Appelbaum G, Onate J. Neuroplasticity following anterior cruciate ligament injury: a framework for visual-motor training approaches in rehabilitation. J Orthop Sports Phys Ther 2015;45:381-93.
65. Farraye BT, Simon JE, Chaput M, et al. Development and Reliability of a Visual-Cognitive Reactive Triple Hop Test. J Sport Rehabil 2023;32:802-9.

© AME Publishing Company.

66. Ardern CL, Glasgow P, Schneiders A, et al. 2016 Consensus statement on return to sport from the First World Congress in Sports Physical Therapy, Bern. Br J Sports Med 2016;50:853-64.
67. Burgi CR, Peters S, Ardern CL, et al. Which criteria are used to clear patients to return to sport after primary ACL reconstruction? A scoping review. Br J Sports Med 2019;53:1154-61.
68. Logerstedt DS, Scalzitti D, Risberg MA, et al. Knee Stability and Movement Coordination Impairments: Knee Ligament Sprain Revision 2017. J Orthop Sports Phys Ther 2017;47:A1-A47.
69. Kotsifaki A, Korakakis V, Graham-Smith P, et al. Vertical and Horizontal Hop Performance: Contributions of the Hip, Knee, and Ankle. Sports Health 2021;13:128-35.
70. Xiao M, van Niekerk M, Trivedi NN, et al. Patients Who Return to Sport After Primary Anterior Cruciate Ligament Reconstruction Have Significantly Higher Psychological Readiness: A Systematic Review and Meta-analysis of 3744 Patients. Am J Sports Med 2023;51:2774-83.
71. Nedder VJ, Raju AG, Moyal AJ, et al. Impact of Psychological Factors on Rehabilitation After Anterior Cruciate Ligament Reconstruction: A Systematic Review. Sports Health 2025;17:291-8.
72. Sell TC, Zerega R, King V, et al. Anterior Cruciate Ligament Return to Sport after Injury Scale (ACL-RSI) Scores over Time After Anterior Cruciate Ligament Reconstruction: A Systematic Review with Meta-analysis. Sports Med Open 2024;10:49.
73. Paterno MV, Rauh MJ, Schmitt LC, et al. Incidence of Second ACL Injuries 2 Years After Primary ACL Reconstruction and Return to Sport. Am J Sports Med 2014;42:1567-73.
74. Webster KE, Feller JA. Exploring the High Reinjury Rate in Younger Patients Undergoing Anterior Cruciate Ligament Reconstruction. Am J Sports Med 2016;44:2827-32.
75. Beischer S, Gustavsson L, Senorski EH, et al. Young Athletes Who Return to Sport Before 9 Months After Anterior Cruciate Ligament Reconstruction Have a Rate of New Injury 7 Times That of Those Who Delay Return. J Orthop Sports Phys Ther 2020;50:83-90. Erratum in: J Orthop Sports Phys Ther. 2020 Jul;50(7):411.
76. Kotsifaki R, King E, Bahr R, et al. Is 9 months the sweet spot for male athletes to return to sport after anterior cruciate ligament reconstruction? Br J Sports Med 2025;59:667-75.
77. Arundale AJH, Bizzini M, Dix C, et al. Exercise-Based Knee and Anterior Cruciate Ligament Injury Prevention. J Orthop Sports Phys Ther 2023;53:CPG1-CPG34.

doi: 10.21037/aoj-2026-0034
Cite this article as: Carothers R, Drazick AT, Page P, Cook P, Hargis B, Burnham JM. Recalibrating anterior cruciate ligament reconstruction rehabilitation: integrating mechanistic evidence, criterion-driven progression, and risk-informed return-to-sport decisions: a narrative review. Ann Joint 2026;11:52.

© AME Publishing Company.