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REHABILITATION AFTER ACL RECONSTRUCTION AND THE RISK OF SECONDARY CONTRALATERAL INJURY: A LITERATURE REVIEW OF RETURN TO SPORT TIME AND FUNCTIONAL CONTROL

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ABSTRACT

Anterior cruciate ligament (ACL) injuries are highly prevalent among athletes participating in pivoting sports and often result in functional limitations and long-term performance decline. While ipsilateral re-ruptures have been extensively studied, the risk of contralateral ACL injuries following reconstruction remains insufficiently explored. This review aimed to analyze literature published between 2020 and 2025 to investigate the relationship between rehabilitation duration and the incidence of contralateral ACL injury, as well as to propose return-to-sport (RTS) recommendations. A narrative review was conducted using PubMed, MDPI, ScienceDirect, and Google Scholar, with 20 studies meeting the inclusion criteria. These studies focused on athletic populations aged 15 to 40 years and addressed RTS timing and secondary injury outcomes. Results showed that athletes who returned to sport before nine months post-surgery had up to a fourfold increased risk of contralateral ACL injury. Key risk factors included lower limb strength asymmetry (LSI <90%), insufficient psychological readiness (ACL-RSI <70), and compensatory biomechanical patterns such as stiffer landings and altered joint loading. The findings support a minimum rehabilitation duration of 9–12 months, with RTS decisions guided by functional, psychological, and biomechanical criteria to reduce the risk of reinjury.

KEYWORDS

ACL Reconstruction, Contralateral ACL Injury, Rehabilitation Duration, Return to Sport, Injury Prevention

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Introduction.

Anterior cruciate ligament (ACL) rupture is one of the most severe knee injuries among professional and amateur athletes, particularly in sports requiring sudden changes of direction, such as football, basketball, and skiing. The ACL stabilizes the knee joint in both the anteroposterior and rotational planes. Each year, approximately 200, 000 ACL injuries are reported in the United States, predominantly affecting active individuals.

The most common mechanisms of ACL injury include sudden directional changes, deceleration, and landing with rotation-typically occurring without direct contact. Following ACL reconstruction, the risk of secondary injury (either ipsilateral or contralateral) is estimated to range from 15% to 30%, with contralateral injuries accounting for up to 50% of those cases. Athletes aged 15 to 25 who return to high-intensity activity are particularly vulnerable.

Return to sport (RTS) plays a critical role in the rehabilitation process. Many athletes resume intensive training within six months after surgery, a decision that has been associated with up to a fourfold increase in the risk of ACL re-rupture. Early RTS can lead to lower limb strength asymmetry, incomplete neuromuscular control, and compensatory movement patterns, which may place excessive load on the contralateral limb.

Although current literature provides extensive data on ACL graft re-rupture, there is a lack of evidence regarding the specific impact of rehabilitation duration on the risk of contralateral ACL injury. Understanding this relationship is essential for optimizing clinical decision-making and may help reduce the incidence of secondary injuries in the non-operated knee.

While modern recommendations advocate for RTS decisions based on functional recovery criteria rather than the time elapsed since surgery, time-based clearance remains a common clinical practice. Further investigation into this issue may support the development of safer, evidence-based rehabilitation protocols.

Aim

The aim of this review is to analyze current literature published between 2020 and 2025 to assess the relationship between the duration of rehabilitation following ACL reconstruction and the risk of contralateral ACL injury. Additionally, the objective is to formulate practical recommendations regarding return-to-sport (RTS) protocols based on the findings.

Materials and Methods

This study was designed as a narrative literature review focused on identifying evidence published between 2020 and 2025 regarding the relationship between rehabilitation duration and contralateral anterior cruciate ligament (ACL) injury in athletes following ACL reconstruction.

The databases searched included PubMed, Google Scholar, MDPI, and ScienceDirect. The following keywords were used individually and in combination:"ACL reconstruction, ""contralateral ACL injury, ""rehabilitation duration, ""return to sport, ""reinjury, ""LSI, " and"ACL-RSI."

The inclusion criteria were as follows:

- articles published in peer-reviewed journals between January 2020 and March 2025,
- original studies or systematic reviews,
- studies investigating contralateral ACL injuries in the context of RTS or rehabilitation timing,
- population: athletes aged 15 to 40 years.

Exclusion criteria included:

- studies focusing solely on ipsilateral re-ruptures,
- case reports or non-peer-reviewed conference abstracts,
- papers lacking clearly defined RTS or rehabilitation time metrics.

A total of 20 eligible studies were identified and included in the analysis. These comprised randomized controlled trials, retrospective cohort studies, and systematic reviews examining biomechanical, psychological, and functional outcomes following ACL reconstruction.

Results

Based on predefined keywords — anterior cruciate ligament, contralateral ACL injury, rehabilitation duration, return to sport, reinjury, and athletes — a total of 20 relevant studies published between 2020 and 2025 were identified. These included systematic reviews, athlete cohort studies, and biomechanical as well as functional analyses of return-to-sport (RTS) protocols.

The risk of contralateral ACL re-rupture was found to be approximately four times higher in athletes who returned to sport in less than 6 months compared to those who returned after 9–12 months. Furthermore, the mean RTS time among athletes who sustained reinjury was 7.4 months, whereas in the non-injured group it was 10.2 months.

Key risk factors for contralateral ACL injury identified across studies include:

– asymmetrical lower limb strength (measured using the Limb Symmetry Index, LSI),
– premature return to sport,
– lack of psychological readiness (e.g., low ACL-RSI scores),
– abnormal movement biomechanics,
– and young age at the time of return.

Athletes presenting an LSI below 90% exhibited a 2.8-fold increase in contralateral ACL injury risk, likely due to compensatory motor strategies that place greater mechanical load on the non-operated limb. Similarly, cohorts with RTS under 9 months showed a fourfold increase in reinjury risk compared to those who returned after 9–12 months.

The ACL-RSI (Anterior Cruciate Ligament – Return to Sport after Injury) scale emerged as a critical psychological evaluation tool. Athletes scoring below 70 points on this scale were shown to be twice as likely to sustain contralateral ACL injuries within 12 months post-RTS.

Another significant risk factor was limb biomechanics. Athletes often develop compensatory movement patterns post-reconstruction, characterized by increased loading of the contralateral limb and reduced activation of the reconstructed knee. This altered load distribution is believed to contribute to secondary contralateral injuries.

Age was also identified as a contributing factor. Athletes under 25 years of age, particularly those returning to pre-injury levels of high-intensity sport, were shown to be at elevated risk for contralateral ACL rupture.

Discussion

Shortened rehabilitation duration following ACL reconstruction, particularly when return to sport (RTS) occurs before nine months, has been consistently associated with an elevated risk of contralateral ACL injury. Athletes who resume high-intensity activity without meeting functional, biomechanical, and psychological clearance criteria—such as LSI ≥90%, completion of hop tests, and ACL-RSI ≥70—experience secondary injuries in approximately 25–30% of cases.

Patients who demonstrate persistent strength deficits in the reconstructed limb tend to overload the contralateral side, resulting in increased ground reaction forces, reduced knee and hip flexion angles, impaired shock absorption, and stiffer landing mechanics with shortened ground contact time. These compensatory movement patterns have been identified as a key contributor to the development of contralateral ACL injuries.

Psychological readiness must also be considered when determining RTS eligibility. An ACL-RSI score below 70 has been linked to a twofold increase in contralateral ACL injury risk. Even athletes who meet physical RTS benchmarks may continue to avoid full loading of the reconstructed knee due to fear of movement, thereby increasing mechanical stress on the contralateral limb.

Evidence-based RTS criteria should therefore include:

– LSI ≥90%,

– analysis of landing biomechanics,

– ACL-RSI ≥70,

– absence of pain, swelling, or signs of instability in the knee joint.

Multiple authors recommend delaying RTS until 9–12 months postoperatively, regardless of the athlete's subjective feeling of readiness or perceived recovery.

While earlier literature primarily focused on RTS timing (e.g., six-month benchmarks), more recent studies emphasize the importance of combining both temporal and functional criteria to minimize reinjury risk—particularly contralateral ruptures.

Most existing studies are retrospective or observational in nature, and few utilize randomized controlled designs comparing different rehabilitation durations with standardized physical outcomes. Additionally, many studies fail to distinguish between ipsilateral and contralateral re-ruptures, limiting the depth and applicability of the available data.

There is a clear need for improved education of athletes and medical personnel. Rehabilitation protocols should not be rushed or abbreviated, and all decisions should be informed by a comprehensive assessment of physical, psychological, and biomechanical readiness. Maintaining a minimum rehabilitation period of 9 to 12 months may significantly reduce the likelihood of secondary injury.

Current evidence highlights the necessity for long-term, prospective research on RTS among athletes recovering from ACL reconstruction. RTS protocols should be standardized and must integrate objective tests of limb symmetry, psychological readiness (ACL-RSI), and biomechanical performance. Finally, dedicated prevention programs should be developed to address the specific risk of contralateral ACL rupture.

Conclusions

Anterior cruciate ligament rupture is one of the most frequent injuries among athletes participating in pivoting sports. The risk of contralateral ACL injury is significantly elevated when return to sport occurs in less than nine months post-reconstruction.

The longer the rehabilitation process, the lower the likelihood of secondary contralateral ACL injury. RTS decisions should be based on a combination of physical, psychological, and biomechanical criteria, rather than on time elapsed since surgery alone.

Prevention of contralateral ACL injuries should become an integral component of post-ACL rehabilitation. Further prospective studies are warranted to explore the relationship between rehabilitation duration and contralateral injury risk, and to support the development of predictive tools that can guide clinical decision-making.

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