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Consensus Statement

Return to sport soccer after anterior cruciate ligament reconstruction: ISAKOS consensus

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ABSTRACT

Introduction: Many factors can affect the return to pivoting sports, after an Anterior Cruciate Ligament Reconstruction. Prehabilitation, rehabilitation, surgical and psychological aspects play an essential role in the decision to return to sports.

The purpose of this study is to reach an international consensus about the best conditions for returning to sports in soccer—one of the most demanding level I pivoting sports after anterior cruciate ligament (ACL) reconstruction.

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Methods: 34 International experts in the management of ACL injuries, representing all the Continents were convened and participated in a process based on the Delphi method to achieve a consensus. 37 statements related to ACL reconstruction were reviewed by the experts in three rounds of surveys in complete anonymity. The statements were prepared by the working group based on previous literature or systematic reviews. Rating agreement through a Likert Scale: strongly agree, agree, neither agree or disagree, disagree and strongly disagree was used. To define consensus, it was established that the assertions should achieve a 75% of agreement or disagreement.
Results: Of the 37 statements, 10 achieved unanimous consensus, 18 non-unanimous consensus and 9 did not achieve consensus. In the preoperative, the correction of the range of motion deficit, the previous high level of participation in sports and a better knowledge of the injury by the patient and compliance to participate in Rehabilitation were the statements that reached unanimous consensus. During the surgery, the treatment of associated injuries, as well as the use of autografts, and the addition of a lateral extra-articular tenodesis in some particular cases (active young athletes, <25 years old, hyperlaxity, high rotatory laxity and revision cases) obtained also 100% consensus.
In the postoperative period, psychological readiness and its validation with scales, adequate physical preparation, as well as not basing the RTSS purely on the time of evolution after surgery, were the factors that reached unanimous Consensus.
Conclusions: The consensus statements derived from this international ISAKOS leaders, may assist clinicians in deciding when to return to sports soccer in patients after an ACL reconstruction. Those statements that reached 100% consensus have to be strongly considered in the final decision to RTS soccer.

What are the new findings

- Return to sport soccer after anterior cruciate ligament reconstruction must be based considering multifactorial variables that can play a role in the pre op, surgery and post operative stages of this process.
- In the pre-operative phase, the panel of experts reached unanimous consensus in the correction of the ROM deficit, the previous high level of participation in sports and a better knowledge of the injury by the patient and compliance to participate in Rehabilitation, as relevant factors in the decision to return to sport soccer.
- During the surgical procedure, the treatment of associated injuries, as well as the use of autografts, and the addition of a lateral extra-articular tenodesis in some particular cases (active young athletes, <25 years old, hyperlaxity, high rotatory laxity and revision cases) reached the unanimous consensus and could be associated with a higher return to sports.
- In the post-operative phase, the psychological readiness and its validation with scales, adequate physical preparation, as well as not basing the RTSS purely on the time of evolution after surgery are the factors that reached unanimous Consensus and could be relevant in the final decision to return to sport soccer, after ACL reconstruction.

Introduction

Anterior cruciate ligament reconstruction (ACLR) is considered the gold standard treatment for active patients with an ACL injury. Several factors may affect the outcome of ACL reconstruction surgery, including surgical-related factors and pre- and post-operative rehabilitation factors [1,2,65,91]. Between others, early ACLR increases the incidence of developing joint stiffness; however, delayed ACLR decreases muscle strength and increases the incidence of additional injuries [3,4]. Psychological aspects also play an essential role and fear of re-injury was the most frequent cause of not returning to sports (RTS) in some patients [5,12].

Evidence suggests a role of a multimodal algorithmic approach that factors in time, graft biology and functional testing in return-to-play decision-making after ACLR [6,36,65]. Various objective criteria have been used to help clinicians to decide when athletes are ready for RTS. A systematic review [7] has questioned the ability of currently available tests to evaluate the return to sports (RTS), showing high variability in defining, assessing, interpreting and reporting RTS following ACLR.

There is limited evidence in the literature regarding the return to specific sports at specific activity levels. Seto et al. reported that athletes, who participated in pivoting sports, were less successful in returning to preinjury activity level after ACLR [8]. Other authors suggest that competitive athletes return to preinjury level of activity and sport-related function more quickly and successfully than non-athletes. A widely accepted guideline is that return to full activity should not be permitted until six months postoperatively; however, a range of 4.1–8.1 months for RTS has been reported [9].

Football (soccer) is a sport where the player faces many challenges when returning to competition following an ACLR. Soccer involves many cuttings and twisting motions, putting the player at risk of a second ACL injury. The soccer player usually must deal with high pressure of his entourage (club, coach) and the risk of jeopardizing his career, while pursuing the goal of a successful RTS. Physiotherapists play an essential role in monitoring a closely supervised criteria-based program and in guiding the athlete during the rehabilitation and training process [10,11].

The literature is not consistent in recommending some agreement in return to sports soccer after an ACLR. This study aims to reach an international consensus about the best conditions for returning to sports in soccer (RTSS), one of the most demanding level I pivoting sports after ACLR.

Methods

This consensus was performed based on the Delphi method which allows structuring a communication process of experts organized in a group-panel to shed light on a research problem [12, 93]. An international working group was created (4 experts) with a facilitator who prepared a list of statements. A questionnaire of 37 statements related to ACLR was applied to orthopedic knee surgeons experts in the subject. The questions were divided into:

(A) Preoperative factors that could affect RTSS (9 questions)
(B) Operative factors that could affect RTSS (9 questions)
(C) Postoperative factors that could affect RTSS (19 questions)

The expert panel answered three rounds of surveys in anonymity. The first round allowed respondents to include comments and rating agreement through a Likert Scale: strongly agree, agree, neither agree or disagree, disagree and strongly disagree.

Consensus was defined when the assertions achieved a 75% of agreement. Cohen's Kappa index was used to indicate stability between the second and third rounds [94].

The expert panel was formed based on a nominative process to recognize the relevant experts in the research topic either because of their knowledge and experience, together with their willingness to participate. **The selection criteria and composition of the panel are shown in** Fig. 1.

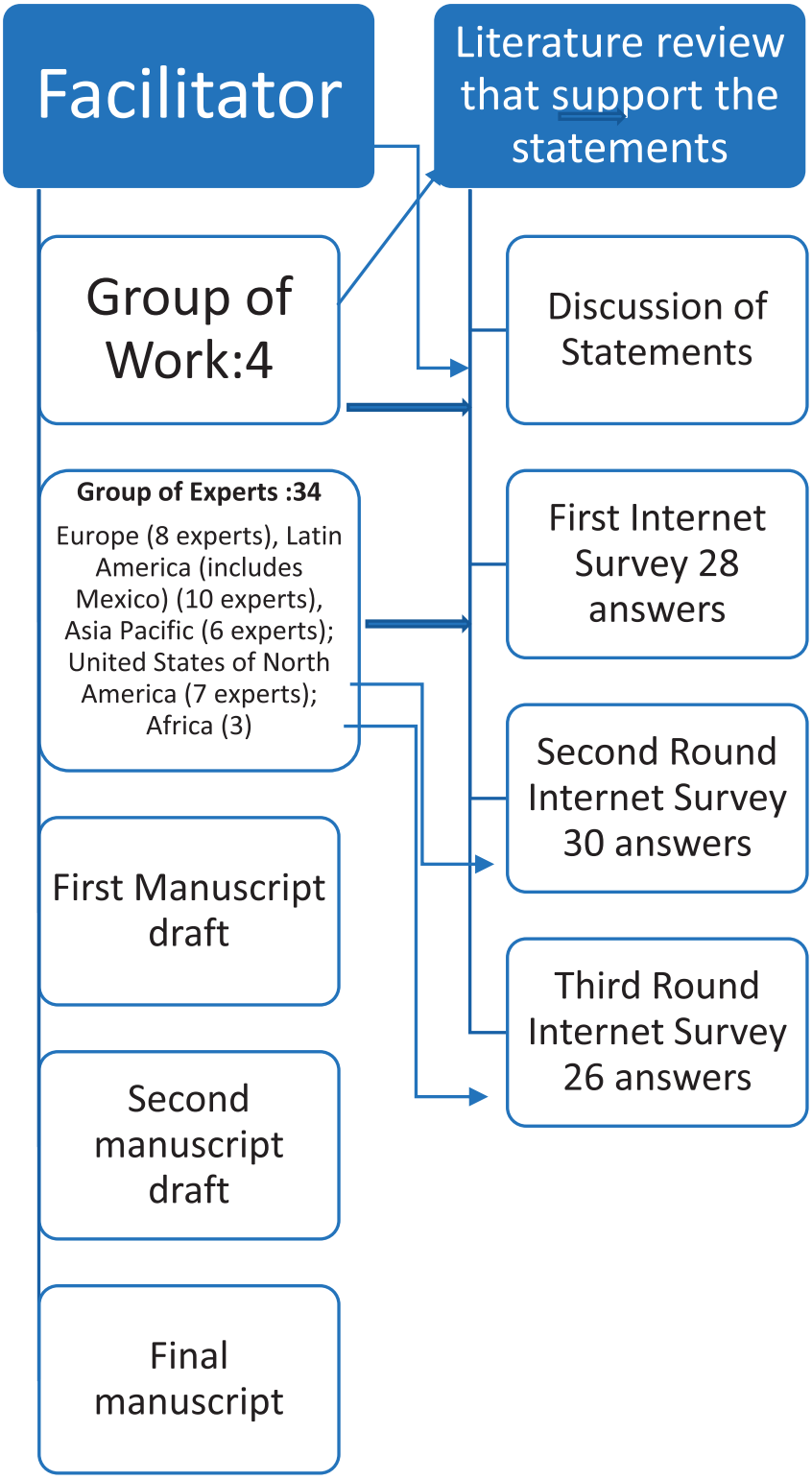

Fig. 1. Show the selection criteria and composition of the panel of experts, and the sequence of work.

Fig. 1. (*continued*).

Results

Of the 37 statements discussed by this working group, 28 achieved consensus, 10 unanimous and 18 non-unanimous and 9 did not achieve consensus (in statements #15 and #24 there was an almost consensus against the statements) (Tables 1–3).

The 37 finalized statements (third round), with supporting literature, are as follows.

Preoperative factors that could affect RTS in soccer

1. "*Time of surgery (more than three months after the injury) is one of the factors that should be considered in affecting RTS in soccer*": **Consensus 76.9%**

Many studies favour that waiting some time (up to 3 months) before reconstruction, improve the functional results, with better clinical scores in the postoperative period [9,10,75].

Shelbourne et al. [66] have concluded in an increase in arthrofibrosis in patients who had undergone ACLR within the first week of injury [63,64,66]; however, other studies have not found significant differences in knee range of motion (ROM) between patients who underwent early reconstruction versus those who waited at least 6 weeks [68].

Conclusion: **Moderate consensus**. The decision of when to undergo ACLR is likely multifactorial. The optimal timing of ACLR is an essential clinical decision that affects patient outcomes and RTS soccer significantly. But Timing of surgical intervention may only be one factor that should be considered when determining the optimal timing of surgery.

2. "*Wait for about three weeks to allow resolve symptoms related to inflammatory and proliferative phases. After that period, we can proceed with the ACLR, and it will not influence the RTS in soccer*": **Consensus 80.8%**

Waiting for the resolution of the inflammatory process before proceeding with the surgery is a factor that can influence better outcomes [13] as there is a strong association between preoperative irritation of the knee and arthrofibrosis [14]. With the appearance of arthrofibrosis, the RTS activities may be delayed and impaired [15]. Interestingly, those individuals who underwent surgery after 4 weeks with an irritated knee had a similar chance of developing arthrofibrosis as those who underwent an earlier reconstruction [67].

Conclusion: **High consensus.** More important than time alone, objective criteria about the inflammatory phase of the knee preoperative including perioperative swelling, oedema, hyperthermia and ROM are important indicators of when surgery should be performed.

3. "*Preoperative ROM deficit (less than full extension, and or less than 90° of flexion) should be corrected before surgery as it can affect the RTS in soccer*": **Consensus 100%**

Some studies conclude that the preoperative ROM deficit results in worse functional results at one year after ACLR [16,75] and could be a predictor of reduced postoperative ROM, and that symmetrical full ROM can be achieved preoperatively and has been shown to reduce the risk of arthrofibrosis improving the outcomes postoperatively [19,69–71].

Conclusion: **Consensus 100%.** An important indicator of patient readiness for surgery is the achievement of full symmetrical ROM before undergoing ACLR.

4. "*Quadriceps' strength should be evaluated and improved before surgery as can affect the RTS in soccer*": **Consensus 65.4%**

Preoperative training provides a significant positive impact on functional performance of the knee, with muscle control exercises and muscle co-contraction with particular attention to the quadriceps providing higher rates of RTS and a trend towards a shorter time to the RTS [17–20,73]. Eitzen [72] suggest that ACLR should not be performed before quadriceps muscle strength deficits of the injured limb is less than 20% of the uninjured limb.

Conclusion: **No consensus.** Although the literature supports the fact that quadriceps strength should be evaluated and restored before ACLR, our expert panel did not agree with this statement.

5. "*In patients who still have pain and effusion, delayed surgery should be considered because it can affect RTS in soccer*": **Consensus 96.2%**

Recent literature shows the association between poor patient outcomes with significant inflammatory phenomena before surgery [18,21,73]. Eitzen et al. [18] showed that 3.9% of the patients presented symptoms such as swelling and pain during or after pre-rehabilitation associating magnetic resonance images due to suspicion of other intra-articular pathologies such as a meniscus tear, which should be adequately evaluated before reconstruction surgery.

Conclusion: **High consensus.** The knee status before surgery may be a more critical factor than injury-to-surgery interval in determining the optimal timing of reconstruction.

6. "*RTS in soccer is associated with a high level of preoperative sports participation*": **Consensus 100%**

Table 1
Statements that achieve consensus (75% agree or disagree) at the end of the third round. Descending percentage order.

Statements	Percentage of consensus in the agree position
P3. Preoperative ROM deficit (less than full extension, and or less than 90° of flexion) should be corrected before surgery as it can affect the RTSS	100.0%
P6. RTSS is associated with a high level of preoperative sports participation.	100.0%
P7. A better understanding of the injury, surgery and the importance of subsequent rehabilitation and compliance of the patient with this Rh, is one the most critical factors that can affect the RTSS.	100.0%
P13. Allografts allow faster immediate postoperative recovery and less operative pain BUT delayed incorporation/remodelling and display higher graft failure rates.	100.0%
P16. Cartilage and meniscal associated injuries, should be managed concomitantly with ACL reconstruction as these can be essential in the making decision to RTSS.	100.0%
P17. Autografts are more successful in RTSS and have less failure rates compared with allografts, especially in active young athletes.	100.0%
P27. In addition to physical readiness, the athlete's psychological state is crucial for RTSS timing and outcomes, so a Psychological validate scale should be used as an essential tool to make the correct decision for RTSS.	100.0%
P31. Purely Time-based RTSS should not be used as a single and definitive factor to decide readiness parameter in RTSS.	100.0%
P35. Psychological readiness for RTSS is essential after ACLR since this is a predictor for returning to the pre-injury level and secondary ACL injuries of the sport in amateur athletes.	100.0%
P5. In patients who still have pain and effusion, delayed surgery should be considered because it can affect RTSS.	96.2%
P19. RTSS should be based on the participation of the patient in a complete rehabilitation program with objective goal-based progressions and objective criteria to discharge to sports participation, known to the patient, as a minimum requirement.	96.2%
P21. RTSS decision-making must include objective physical examination data as anterior drawer test, Lachman test, pivot shift test, ROM, effusion, pain, dial test, among others.	96.2%
P22. Before RTSS, patients should pass a standardized, validated, objective analysis. These include isokinetic testing (strength symmetry evaluation), and hop tests (movement quantity and quality evaluation). When determining a safe RTPS, test results should demonstrate a Limb Symmetry Index (LSI) of 90%–100%, which is recommended to reduce the recurrence of injury and possible long-term complications.	96.2%
P26.RTSS should involve the assessment of specific functional skills that demonstrate the appropriate physical performance such as quality of movement, strength, ROM, balance and neuromuscular control of the lower extremity and body.	96.2%
P32. Other important factor for RTSS is the quality of movement. Using solely the LSI can mask kinematic deficits (movement quality)"	96.2%
P8. An essential element during the preoperative period for RTS is the completion of a rehabilitation program (pre-habilitation). The goals of a pre-habilitation program include reducing inflammation, swelling and pain, restoring normal range of motion (ROM), strength, neuromuscular control and gait.	92.3%
P18. In Young patients (<25 years old), hyperlaxity, high rotatory laxity and revision cases, we may consider adding an extra-articular lateral tenodesis to the ACL reconstruction in order to a better RTSS.	92,3.0%
P29. Even though, as a doctor, one might be satisfied with the outcome of treatment (adequate graft placement and fixation, symmetric strength, excellent agility, the patient is back to playing his sport), the patient might still have a different perspective regarding a successful outcome. Therefore, self- personal satisfaction tests should be applied before RTSS.	92.3%
P20. RTSS should include a questionnaire of the patient's symptoms as pain, swelling, instability, giving way, locking sensation, stiffness among others.	88.5%
P34. Most of the current test batteries can be used to determine the likelihood that patients resume RTSS at pre-injury level, but fail in identifying patients who are at risk for a second ACL injury.	88.5%
P37. All parameters used for a safe RTSS will also act as preventive measures for a new ACL injury	88.5%
P28. Patient's age should be considered as an important factor in the decision making for RTSS.	88,5%
P12. For the elite athlete who demands the highest level of stability and function, it may be beneficial to receive an anatomic reconstruction, which will more closely recreate the pre-injury function of their knee, so an Anatomical placement of the graft should be privileged if we want a better RTSS.	84.6%
P33. Increasing the quality of the ACLR rehabilitation by implementing more progressive strength training results in higher passing rates for RTSS strength criteria, which potentially increase RTSS rates and decrease the risk for second ACL injury.	84.6%
P2. Wait for about three weeks to allow resolve symptoms related to inflammatory and proliferative phases. After that period, we can proceed with the ACLR, and it will not influence the RTSS.	80.8%
P36. Using patient reported-outcomes as IKDC form, and Tegner activity rating scale, give us a reliable and valid measure of patient-reported function in the making decision to RTSS.	80.8%
P1. Time of surgery (more than 3 months after the injury) is one of the factors that should be considered in affecting RTSS.	76.9%
P30. At this time, using MRI to investigate graft healing is promising; however, it has not been validated to ensure graft maturity and biomechanical strength. MRI decisively should not be used as an isolated parameter for deciding the RTSS.	76.9%

Table 2
Statements that do not reach consensus (75% agree or disagree) at the end of the third round.

Statements	Percentage of consensus in the agree position
P4. Quadriceps' strength should be evaluated and improved before surgery as can affect the RTSS	65.4%
P9. Evaluate the EPIC (estimated pre injury capacity) could be a beneficial tool in this phase in order to a better RTSS.	69.2%
P10. Graft choice is one of the most important factors that could affect the RTSS.	69.2%
P11. In patients with a high level of intensity of pivoting sports practice, BTB should be the favourite graft as an earlier graft ligamentization allows the implementation of a more aggressive rehabilitation program after surgery, and therefore, a faster RTSS.	69.2%
P14. Ideally, proper tension should avoid the laxity caused by the insufficient ligament, without causing over constriction that may lead to increased joint contact pressures and resultant in collagen myxoid degeneration and intrasubstance graft necrosis. Hence, graft tension at the end of the surgery is one of the factors that could affect the RTSS.	65.4%
P15. Enhance the biological ligamentization process during the surgery, should be fundamental in improving RTSS.	23.1%
P23. The hop test battery should always include single-leg hop, triple hop, crossover hop and single-leg vertical hop	73.1%
P24. The single-leg vertical hop test has been the most recommended for use in functional performance hop test batteries because of its value in discriminating between healthy versus ACL-injured limbs according to previous literature.	19.2%
P25. Isokinetic quadriceps strength test should be performed with 3 submaximal (i.e. 50% effort) practice knee extension contractions being more reliable at a rate of 60 deg/s before attempting the maximal effort trials.	65.4%

Table 3
Variability in answers between the different rounds (round II y III).

Question	Disagree	Center	Agree	Sum	Variation
P1	23.1	0.0	57.7	80.8	19.2
P2	15.4	3.8	80.8	100	0.0
P3	0.0	0.0	100	100	0.0
P4	3.8	15.4	57.7	76.9	23.1
P5	0.0	3.8	96.2	100	0.0
P6	0.0	0.0	100	100	0.0
P7	0.0	0.0	100	100	0.0
P8	0.0	7.7	92.3	100	0.0
P9	0.0	19.2	61.5	80.7	19.3
P10	7.7	11.5	61.5	80.7	19.3
P11	7.7	19.2	57.7	84.6	15.4
P12	11.5	3.8	84.6	99.9	0.1
P13	0.0	0.0	100	100	0.0
P14	3.8	23.1	61.5	88.4	11.6
P15	3.8	50	15.4	69.2	30.8
P16	0.0	0.0	100	100	0.0
P17	0.0	0.0	100	100	0.0
P18	0.0	7.7	92.3	100	0.0
P19	0.0	3.8	96.2	100	0.0
P20	0.0	7.7	88.5	96.2	3.8
P21	0.0	3.8	96.2	100	0.0
P22	0.0	3.8	96.2	100	0.0
P23	3.8	7.7	69.2	80.7	19.3
P24	3.8	53.8	7.7	65.3	34.7
P25	0.0	30.8	57.7	88.5	11.5
P26	0.0	3.8	96.2	100	0.0
P27	0.0	0.0	100	100	0.0
P28	3.8	7.7	88.5	100	0.0
P29	0.0	7.7	92.3	100	0.0
P30	7.7	15.4	76.9	100	0.0
P31	0.0	0.0	100	100	0.0
P32	0.0	3.8	96.2	100	0.0
P33	3.8	11.5	84.6	99.9	0.1
P34	0.0	11.5	69.2	80.7	19.3
P35	0.0	0.0	100	100	0.0
P36	11.5	7.7	80.8	100	0.0
P37	3.8	7.7	88.5	100	0.0

A meta-analysis including 57 studies to assess the level of preoperative sports participation has found that elite athletes were more likely to return to any type of sport [22]. However, those returning to level I sports after ACL injury have a 4.32 to 18.40 times higher reinjury rate. The 2-year reinjury risk in patients who returned to level I sports after ACL surgery was 29.7% (22 of 74) [23].

Conclusion: **Consensus 100%.** Elite athletes with higher levels of preinjury athletic skills may be more likely to return to their preinjury level of the sport.

7. "*A better understanding of the injury, surgery, and the importance of subsequent rehabilitation (Rh) and compliance of the patient with this Rh is one the most critical factors that can affect the RTS in soccer*": **Consensus 100%**

Knowing the movement patterns associated with the injury, resolving deficiencies, and eliminating predisposing factors for a future injury through a rehabilitation protocol provides the best opportunity for RTS without further injuries [24]. There has been substantial research attempting to formulate an evidence-based clinical practice guidelines of what best practice ACL rehabilitation programs should include [42,44]. It is crucial to consider personal factors that may act as barriers or facilitators to rehabilitation. Increased awareness and understanding of these factors may offer new insights and opportunities to improve long-term ACLR outcomes [74–76].

Conclusion: **Consensus 100%.** Identifying the barriers and facilitators of adherence and participation in ACL rehabilitation programs, provides an opportunity to address personal, environmental, and treatment-related factors, increasing the likelihood of patients complying with current best evidence rehabilitation to improve outcomes such as return to sport rates.

8. "An essential element during the preoperative period for RTS is the completion of a rehabilitation program (prehabilitation). The goals of a pre-habilitation program include reducing inflammation, swelling, and pain, restoring normal ROM, strength, neuromuscular control, and gait" **Consensus 92.3%**

Recent studies have supported implementing a prehabilitation program to optimize preoperative knee function [18]. This program comprises two phases: the first one seeks to resolve the inflammatory symptoms and the complete ROM deficits of the knee. The second phase is started, as soon as these objectives are met, aiming to restore muscle strength and adequate neuromuscular responses [18,20] Some studies [26,76], showed that groups with prehabilitation had better functional results and higher rates of RTS 2 years after ACL reconstruction than the non-experimental group.

Conclusion: **High consensus.** Although the evidence is still limited and there is only very-low quality evidence to support the use of prehabilitation before ACLR, the panel of experts believes that outcomes of muscular strength, function and patient-reported symptoms can be improved when a prehabilitation program is implemented.

9. "Evaluate the estimated pre-injury capacity (EPIC) could be a beneficial tool in this case to a better RTS in soccer" **No Consensus: 69.2%**

A recent retrospective cohort study [27] demonstrated that EPIC levels could predict secondary injury compared to postoperative limb symmetry index (LSI; commonly used to determine RTS timing). Another prospective cohort study [28] found that 6 of 8 patients with 90% postoperative LSI and EPIC levels <90% after ACL reconstruction suffered secondary ACL injury. They concluded that the LSI could be overestimating the function of the knee, being the levels of EPIC more sensitive than the LSI in the prediction of second injuries.

Conclusion: **No consensus.** Although some literature favours EPIC versus other parameters in terms of a better criteria for RTS in soccer, the expert panel did not reach an agreement.

Operative factors that could affect RTS in soccer

10. "Graft choice is one of the most important factors that could affect the RTS in soccer"**No consensus 69.2%**

One systematic review [77] demonstrated that ACLR rusing bone-patellar-tendon-bone (BPTB) autografts showed higher overall RTS rates when compared with hamstring (HT) autografts. However, BPTB and HT autografts had similar rates of return to pre-injury levels of performance and re-rupture rates. Less than half of the athletes returned to preinjury status after ACLR with either an HT or BPTB autograft. However, when using allografts, the clinician must be aware that there is a higher risk of failure during the first nine months after reconstruction [23].

Conclusion: **No consensus.** Graft choice was not considered as one of the most critical factors in RTS in soccer.

11. "In patients with a high level of intensity of pivoting sports practice, BPTB should be the favourite graft as an earlier graft ligamentization allows the implementation of a more aggressive rehabilitation program after surgery, and therefore a faster RTS in soccer" **No consensus 69.2%**

BPTB autografts have been considered to have lower revision rates and higher postoperative stability than HT autografts and may be preferable in competitive high-level athletes in contact sports [77]. Xie [78] suggested that BPTB autografts should be used in young and high-demand athletes to enable a greater proportion of patients to return to their preinjury sport postoperatively with higher levels of activity, but despite it provides better initial fixation and allows an early return, has

been associated with different morbidities, such as anterior knee pain and loss of ROM, and longer time to reach the Rh progression milestone than HS [29].

Conclusion: **No consensus.** BPTB should not be prioritized in patients with high demand in pivoting sports allowing a faster RTS in sports.

12. "For the elite athlete who demands the highest level of stability and function, it may be beneficial to receive an anatomic reconstruction, which will more closely recreate the pre-injury function of their knee, so an anatomical placement of the graft should be privileged if we want a better RTS in soccer" **Consensus: 84.6%**

For the elite athlete who demands the highest level of stability and function, has been described that more closely recreating the pre-injury function of their knee through anatomical reconstruction results in increased in situ graft loading, reproducing native kinematics potentially avoiding the development and progression of post-traumatic osteoarthritis. However, there is always a risk of a new knee lesion [1,23].

Conclusion: High consensus. Anatomic reconstruction of the torn ACL could be an important factor in RTSS.

13. "Allografts allow faster immediate postoperative recovery and less operative pain but delayed incorporation/remodeling and display higher graft failure rates**" Consensus: 100%**

Many studies have associated allografts with less anterior pain of the knee and morbidity [1,35,74,79]. However, ligamentization and allograft incorporation are slower and presumably more susceptible to early failure [30]. A systematic review [79] concluded that although no substantial difference in patient-reported function, activity level, and symptoms, the findings highlighted a greater risk for graft failure or revision that may make allograft a less safe treatment modality in ACL reconstruction.

Conclusion: **Consensus 100%.** The use of allografts should be restricted in high demand and pivoting sports because due to associated higher rates of failure.

14. "Ideally, proper tension should avoid the laxity caused by the insufficient ligament, without causing over-constriction that may lead to increased joint contact pressures and resultant in collagen myxoid degeneration and intrasubstance graft necrosis. Hence, graft tension at the end of the surgery is one of the factors that could affect the RTS in soccer" No **consensus 65.4%**

Adequate graft tensioning may be important for restoring normal anteroposterior laxity in ACL reconstruction at the time of graft fixation. The optimal amount of force applied to the graft before fixation is a matter of debate, with most authors recommending between 20 and 90N of initial graft tension. An under-tensioned graft will not restore knee native stability. An over-tensioned graft will pull the femur anteriorly on the tibia and restrict the ROM within the knee. This places the graft at increased risk of damage during normal physiological loading [55–57].

Conclusion: **No consensus.** Graft tension was not considered as a factor that affect the RTS in soccer.

15. "Enhance the biological ligamentization process during the surgery, should be fundamental in improving RTS in soccer" No **consensus 23%**

A systematic review [31] concluded that there is promising evidence that the addition of platelet-rich plasma (PRP) could be a synergic factor in acquiring faster ACL graft maturation, but the clinical implication of this remains unclear. Conversely, there is not an improvement with the addition of PRP in tunnel healing. Regarding the use of stem cells as adjuvants in ACLR, there is still a relative paucity of high-level evidence ligament and tunnel healing; however, early human and animal results support the reparative and immunomodulatory potential of stem cells as an evolving therapeutic, which merits further investigation [80].

Conclusion: **No consensus.** Biological enhancement was not considered as important to improve the RTS in soccer after ACLR.

16. "Cartilage and meniscal associated injuries, should be managed concomitantly with ACLR as these can be essential in the making decision to RTS in soccer" **Consensus 100%**

There is evidence in the literature that the menisci and cartilage state influences outcomes after ACLR [32,33,85]. Concomitant meniscus injuries, either in isolation or in combination with cartilage lesions, render a deterioration of clinical scores and quality of life between 5- and 10-year post surgery follow-up of ACL-reconstructed patients. No such deterioration was seen for patients who had isolated ACL injuries [81].

Articular cartilage injuries are a common clinical problem during ACL reconstruction with an incidence rate of 16–46%. Good results of ACLR combined with the treatment of chondral lesions have been published in many studies with patient satisfaction and improvement in their quality of life [32,33,58,59].

Conclusion: **Consensus 100%.** Cartilage and meniscal associated injuries should be managed concomitantly with ACLR as these can be essential in deciding RTS in soccer.

17. "Autografts are more successful in RTS in soccer and have less failure rates compared with allografts, especially in active young athletes" **Consensus: 100%**

Some studies have shown that autografts are preferred over allografts for primary ACLR in active young individuals due to the increased risk of allograft revision [34]. A case–control study of 2497 patients showed that the probability of re-tearing for subjects with allograft was 13-fold higher compared to the BPTB autograft [35]. Similarly, a systematic review showed that, the risk of graft failure was substantially greater in patients receiving allograft compared with patients receiving autograft [79].

Conclusion: **Consensus 100%.** Autografts are more successful in RTS in soccer than allografts.

18. "In Young patients (<25 years old), hyperlaxity, high rotatory laxity and revision cases we may consider adding a lateral extra-articular tenodesis (LEAT) to the ACLR for a better RTS in soccer" **Consensus: 92.3%**

ACLR with the addition of LEAT can decrease the time to RTS (median: 8 months versus 6 months for those without LEAT) in patients who are exposed to high-grade pivot change, ACL revision, or who met two or more minor criteria such as hypermobility, age under 20 years, failed contralateral ACLR, and elite athletes [36,82]. The STABILITY study and others has also shown that the addition of LEAT can decrease the risk of clinical failure reducing the rate of residual pivot shift and ACL graft retear [82,96].

Conclusion: **High Consensus.** In the high-risk population, we should consider adding a LEAT procedure to obtain a better RTS in soccer and reduce the reinjury risk.

Postoperative factors that could affect RTS in soccer

19. "RTS in soccer should be based on the participation of the patient in a complete rehabilitation program with objective goal-based progressions and objective criteria to discharge to sports participation, known to the patient, as a minimum requirement" **Consensus: 96.2%**

Rehabilitation following ACLR has shifted from a paradigm based on protocols to a goal-based program with objective criteria to progress

through rehabilitation phases [95]. When the patient is ready for RTS, objective criteria must be met to reduce the risk of further injury [83]. Higher levels of motivation during rehabilitation have shown to be associated with higher rates of return to preinjury sport following ACLR [84]. Athlete's value playing an active role in their recovery and setting realistic expectations during rehabilitation contributes to their self-efficacy and recovery [37].

Conclusion: **High consensus.** The patient's participation in a complete rehabilitation program is a critical factor that should be considered in RTS in soccer.

20. "RTS in soccer should include a questionnaire of the patient's symptoms as pain, swelling, instability, giving way, locking sensation, stiffness, among others" **Consensus: 88.5%**

Symptoms such as pain, swelling and instability are one of the postoperative indicators of higher loads concerning the unstable and weakened knee, substantially related to a new knee injury, with the possibility of damage to the reconstructed ACL [23,25]. There are many patient-reported outcome measures (PROMS) that can be used, but these should not be used as isolated criteria for the decision of RTS in soccer.

Conlusion: **High consensus**. Subjective instability or inflammatory symptoms should be investigated in patients before RTS in soccer.

21. "RTS in soccer decision-making must include objective physical examination data as anterior drawer test, Lachman test, pivot shift test, ROM, effusion, pain, dial test, among others" **Consensus: 96.2%**

Clinical tests such as the Lachman, pivot shift and other have served as an index of knee stability both pre- and postoperatively [38,39]. however available high-quality evidence suggests that tests are not helpful on their own, but combinations may prove to be more beneficial both in the pre- and post-operative diagnosis. However only one-fourth of studies use clinical examination as objective criteria for RTS [38].

A systematic review of clinical tests for ACL injury [85] highlights the lack of clinical test accuracy data to support the use of history and physical examination to diagnose an ACL injury. Methodological flaws can overestimate the diagnostic accuracy of these tests [99].

Conclusion: **High consensus.** RTS in soccer should consider objective physical examination to assess knee laxity, ROM, and function.

22. "Before RTS in soccer, patients should pass a standardized, validated, objective analysis. These include isokinetic testing (strength symmetry evaluation) and hop tests (movement quantity and quality evaluation). When determining a safe RTS in soccer, physical performance-based tests results should demonstrate an LSI of 90%–100%, which is recommended to reduce the recurrence of injury and possible long-term complications" **Consensus: 96,2%**

An association has been found between the appearance of a second ACL injury in patients who return without meeting a variety of criteria, including restoration of $\geq$90% of the LSI, finding asymmetric quadriceps strength and asymmetric knee function during jumping at the time of the RTS [37–39]. While values that correlate with perceived "normal" knee function can be provided for functional testing following ACL reconstruction, objective evidence is lacking for determining return to play criteria based on an exact result of a functional test. Many authors have advocated using multiple tests to assess full RTS status [86,91].

Conclusion: **High consensus.** A standardized functional test battery should be applied to patients before RTS in soccer.

23. "The hop test battery should always include single-leg hop, triple hop, crossover hop, and single-leg vertical hop." **No consensus: 73.1%**

Even though passing a test battery including a series of single leg hop tests and isokinetic testing has been associated with lower re-rupture rates following RTS and an increased likelihood of returning to previous sporting levels, the hop and isokinetic tests do not consistently predict successful outcomes following ACL rehabilitation. A systematic review [61] reported no associations between the use of RTS discharge tests and greater risk of reinjury, stating the low quality of evidence affects our ability to make definitive conclusions. Similarly, a critical review [87] concluded that while the ACL hop tests display adequate reliability, the current evidence indicates a lack of consistency in their capacity to predict successful outcomes following rehabilitation either in terms of return to previous performance levels or identifying those at greater risk of re-injury.

Conclusion: **No consensus.** Single leg hop testing should not be considered as an isolated test to decide the readiness of athletes to RTS in soccer.

24. "The single-leg vertical hop test has been the most recommended for use in functional performance hop test batteries because of its value in discriminating between healthy versus ACL-injured limbs according to previous literature" **No consensus: 19.2%**

Petschnig et al. [41] states that the vertical jump test on one leg is sensitive enough to detect functional limitations in the lower limb after ACLR. Other studies have shown that the vertical jump test on one leg provides the lower sensitivity rate to detect knee functional limitations [60].

Some studies applying different hop test, based the RTS criteria in a limb symmetry index of 90% in all hop tests and 85% in isokinetic strength tests, that better inform the clinicians the underlying quadriceps deficits that still present [40,98].

Conclusion: **No consensus.** Single-leg vertical hop test was not considered as the most recommended test to discriminate between a healthy versus ACL-injured limbs. It should not be used as an isolated test before RTS soccer.

25. "Isokinetic quadriceps strength test should be performed with 3 submaximal (*i.e.*, 50% effort) practice knee extension contractions being more reliable at a rate of 60°/s before attempting the maximal effort trials" **Consensus: NO 65,4%**

While isokinetic testing may also be used to assess the quadriceps after ACL reconstruction, it seems that isometric testing is a highly relevant clinical measurement [88]. In this way, there is a lack of consistency in RTS assessments, in particular hop tests and isokinetic test to predict who will sustain a reinjury following ACLR. A systematic review' [62] demonstrated that only 23% of patients passed RTS test batteries, suggesting an apparent paradox that 'passing' an RTS battery was associated with a greater risk of injury to the contralateral limb.

Conclusion: **No consensus.** Isokinetic quadriceps strength test performed with 3 submaximal (*i.e.*, 50% effort) practice knee extension contractions by itself is not a reliable test to be considered for RTSS.

26. "RTS in soccer should involve assessment of specific functional skills that demonstrate the appropriate physical performance such as quality of movement, strength, ROM, balance, and neuromuscular control of the lower extremity and body" **Consensus: 96.2%**

Many papers highlight the key areas that require special attention in a rehabilitation program as the restoration of neuromuscular performance, muscle strength, ROM and quality of movement (kinematics) before RTS, as they can reduce the risk of ACL injury. It is also recommended to consider factors such as time, psychological preparation, self-confidence, stability and jumping tests [42–45,53].

Conclusion: **High consensus.** Assessment of specific functional skills that demonstrate the appropriate physical performance such as

quality of movement, strength, ROM, kinematics, and neuromuscular control of the lower extremity and body should be considered before RTS in soccer.

27. "In addition to physical readiness, the athlete's psychological state is crucial for RTS in soccer timing and outcomes, so a psychological validate scale should be used as an essential tool to make the correct decision for RTS in soccer" **Consensus: 100%**

A recent study [63] highlights the importance of incorporating the evaluation of psychological responses in RTS testing. Psychological readiness measured 9 months after surgery was found to be predictor of RTS 2 years after ACLR, while functional tests had no predictive value. Other studies have shown the importance of psychological readiness before RTS for a faster RTS and to decrease the risk of second ACL injuries [6,51].

Conclusion: **Consensus 100%,** so psychological status should be considered as critical in the decision to RTSS.

28. "Patient's age should be considered as an important factor in the decision making for RTS soccer" **Consensus: 88.5%**

Age is considered as a "non-modifiable" risk factor for second injuries in young patients (<25 years old) [22,41,47]. Many studies showed that younger athletes were more likely to return to their pre-injury level of sport [9,10,89,90]. However, they suggested that age could be a proxy for other factors as younger patients are more likely to return to high-risk sports involving cutting, jumping and pivoting movements. One study showed that younger age was a significant predictor of return to sport, with 81% of patients aged ≤25 years having already returned to level I/II sports at the time of the clinical evaluation. It is reasonable that a young person has a higher level of sports activity and a stronger sense of athletic identity, acting as a positive motivator for RTS and a catalyst for future injuries [22,46,47].

Conclusion: **High consensus.** Age was considered as an important factor related to RTS in soccer.

29. "Even though, as a doctor, one might be satisfied with the outcome of treatment (adequate graft placement and fixation, symmetric strength, excellent agility, the patient is back to playing his sport), the patient might still have a different perspective regarding a successful outcome. Therefore, self-personal satisfaction tests should be applied before RTS in soccer" **Consensus: 92.3%**

Besides clinical and physical performance-based tests, subjective outcomes such as PROMS might have an important role in determining readiness for RTS. They offer a more complete picture of the patient's perception of the actual recovery after ACL surgery [90]. Dissatisfied patients are those who tend not to understand their abilities and limitations in the postoperative period, thus leading to a greater risk of future injuries [48].

Conclusion: **High consensus.** Patient-specific and subjective personal interpretation and satisfaction should be considered before RTS in soccer.

30. "At this time, using magnetic resonance imaging (MRI) to investigate graft healing is promising; however, it has not been validated to ensure graft maturity and biomechanical strength. MRI decisively should not be used as an isolated parameter for deciding the RTS in soccer" **Consensus: 76.9%**

MRI shows a promising modality for evaluating ligament characteristics using measurements such as graft volume and signal intensity to extrapolate the mechanical strength of the graft. MRI-based graft maturity cannot predict clinical and functional outcomes in patients at the first-year follow-up. Graft maturity should not be used as an objective test to determine the appropriate time to RTS during the first year after ACL reconstruction [49, 50, 64].

Conclusion: **Moderate consensus.** MRI should not be used as an isolated and reliable test for RTS in soccer.

31. "Purely time-based RTS in soccer should not be used as a single and definitive factor to decide readiness parameter in RTS in soccer" **Consensus: 100%**

Several studies have demonstrated deficits in muscular strength, kinaesthetic sense, balance and force attenuation 6 months to 2 years following ACLR [7,16,20,26,52]. Therefore, returning to sport at 6 months following ACLR is no longer the expected norm [83]. Grindem et al. [23] showed that RTS 9 months or more after surgery substantially reduces the rate of new injuries and, that by each month, the RTS was delayed after the 6 months, the risk of new knee injuries was reduced by 51%.

Conclusion: **consensus 100%,** purely time-based, should not be used as a parameter to decide RTSS.

32. "Other important factor for RTS in soccer is the quality of movement. Using solely, the LSI can mask kinematic deficits (movement quality)" **Consensus: 96.2%**

A bilateral deficit may lead to a falsely high LSI since LSI is calculated as a ratio between the values of the lower limbs. Buckthorpe et al. [43, 44] indicate that a sufficient LSI may have low levels of absolute resistance leading to a patient being insufficiently prepared to tolerate load demands.

Conclusion: **High consensus.** The LSI is a good test to evaluate functional deficits (hop testing) but should not be used as a single parameter to evaluate knee function for RTS in soccer, as can mask kinematics unbalances.

33. "Increasing the quality of the ACL rehabilitation by implementing more progressive strength training results in higher passing rates in strength criteria, which potentially increase RTS in soccer rates and decrease the risk for second ACL injury" **Consensus: 84,6%**

Progressive strength training in ACL rehabilitation can mitigate commonly reported strength deficits [40]. If proper progressive strength training is implemented, amateur male soccer players after ACL reconstruction achieve similar knee strength after ACLR at 7 months compared to healthy controls [97].

ACL rehabilitation progression should be based on objective criteria and not just time frames [83].

Consensus: **High consensus.** Rehabilitation after ACLR should follow a progressive strengthening program which may increase the rate of RTS in soccer and decrease the rates of a second ACL injury.

34. "Most of the current test batteries can be used to determine the likelihood that patients resume RTS in soccer at pre-injury level, but fail in identifying patients who are at risk for a second ACL injury" **Consensus: 88.5%**

There is still a lack of consistency in the battery of tests used to decide on the athlete's readiness to RTS, with a time-based approach still being used in some studies [40]. A battery of test can identify with some accuracy those at higher risk of graft tear, but not those at risk of secondary ACL injuries [62,92,98].

Conclusion: **High consensus**. Most of the current test batteries for a safe RTS in soccer fail in predicting which athletes are at higher risk of a second ACL injury.

35. "Psychological readiness for RTS in soccer is essential after ACLR since this is a predictor for returning to the pre-injury level and

secondary ACL injuries of the sport in amateur athletes" **Consensus: 100%**

The RTS is multifactorial, requiring both physical and psychosocial recovery after surgery. Physical functioning assessment has traditionally dominated RTS evaluation, but there is emerging evidence for incorporating psychological factors in these decisions. The psychological disposition to return to sports and recreational activity has been a factor strongly associated with the RTS and risk of reinjury [45,51,63].

Conclusion: **Consensus 100%.** Psychological readiness is a crucial factor that should be considered in RTS in soccer.

36. "Using patient-reported outcomes as International Knee Documentation Committee 2000 Subjective Knee (IKDC) Form, and Tegner activity rating scale, give us a reliable and valid measure of patient-reported function in the making decision to RTS in soccer" **Consensus: 80.8%**

The assessment of knee-specific PROMS, such as the IKDC form, has traditionally been regarded as an essential measure of successful outcome after ACLR and is often used in conjunction with other RTS objective measures [38]. An IKDC score $\geq$94.8 predicted a quadriceps LSI $\geq$90% with high sensitivity and moderate specificity suggesting that the patient is at an acceptable level of RTS. Additionally, Tegner physical activity rating assesses the current level of physical activity with acceptable validity [38,52].

Conclusion: **High consensus.** The use of PROMS as IKDC and Tegner could be useful in the making decision to RTS in soccer.

37. "All parameters used for a safe RTS in soccer will also act as preventive measures for a new ACL injury." **Consensus: 88.5%**

The evidence shows conflicting results for the relation between RTS criteria and potential risk for second ACL injury (98, 100). However, most of the tests are carried out to evaluate the safety of RTS as well as to determine the recovered functional capacity. If patients pass, they probably have a lower risk of re-injury [54,61].

Conclusion: **High consensus.** Although there is a controversial literature, the panel of experts believes that all parameters used to RTS in soccer prevent new ACL injury.

Conclusion

Regarding the results of the Consensus, return to sport soccer after an ACL reconstruction is a decision that must be based on multifactorial parameters. The panel of experts strongly recommend taking into account. In the preoperative, the correction of the ROM deficit, the previous high level of participation in sports and a better knowledge of the injury by the patient and compliance to participate in Rehabilitation. During the surgery, the treatment of associated injuries, as well as the use of autografts and the addition of a lateral extra-articular tenodesis in some particular cases (active young athletes, <25 years old, hyperlaxity, high rotatory laxity and revision cases) could be associated with a higher return to sports.

In the postoperative period, psychological readiness and its validation with scales, adequate physical preparation, as well as not basing the RTSS purely on the time of evolution after surgery are the factors that reached unanimous Consensus.

However, despite strong consensus by experts, there is a need for larger randomized trials that analyses better each factor that can participate in RTSS with longer-term follow-up.

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Declaration of competing interest

None of the authors have a Conflict of interest related to this paper.

Appendix A. Supplementary data

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References

[1] Paschos NK, Howell SM. Anterior cruciate ligament reconstruction: principles of treatment. EFORT Open Rev 2017;1:398–408. https://doi.org/10.1302/2058-5241.1.160032.
[2] Ardern CL, Taylor NF, Feller JA, Webster KE. Fear of re-injury in people who have returned to sport following anterior cruciate ligament reconstruction surgery. J Sci Med Sport 2012;15:488–95. https://doi.org/10.1016/jsams.2012.03.015.
[3] Thomas AC, Hubbard-Turner T, Wikstrom EA, Palmieri-Smith RM. Epidemiology of posttraumatic osteoarthritis. J Athl Train 2017;52:491–6. https://doi.org/10.4085/1062-6050-51.5.08.
[4] Bodendorfer BM, Keeling LE, Michaelson EM, Shu HT, Apseloff NA, Spratt JD, et al. Predictors of knee arthrofibrosis and outcomes after arthroscopic lysis of adhesions following ligamentous reconstruction: a retrospective case-control study with over two years' average follow-up. J Knee Surg 2019;32:536–43. https://doi.org/10.1055/s-0038-1655741.
[5] Alswat MM, Khojah O, Alswat AM, Alghamdi A, Almadani MS, Alshibely A, et al. Returning to sport after anterior cruciate ligament reconstruction in physically active individuals. Cureus 2020 Sep;12(9):e10466. https://doi.org/10.7759/cureus.10466. Published online 2020 Sep 15.
[6] Chona D, Eriksson K, Young SW, Denti M, Sancheti PK, Safran M, et al. Return to sport following anterior cruciate ligament reconstruction: the argument for a multimodal approach to optimise decision-making: current concepts. JISAKOS 2021;6(6):344–8. https://doi.org/10.1136/jisakos-2020-000597.
[7] Marom N, Xiang W, Wolfe I, Jivanelli B, Williams 3rd RJ, Marx RG. High variability and lack of standardization in the evaluation of return to sport after ACL reconstruction: a systematic review. Review Knee Surg Sports Traumatol Arthrosc 2022;30(4):1369–79. https://doi.org/10.1007/s00167-021-06594-9.
[8] Seto JL, Orofino AS, Morrissey MC, Medeiros JM, Mason WJ. Assessment of quadriceps/hamstring strength, knee ligament stability, functional and sports activity levels five years after anterior cruciate ligament reconstruction. Am J Sports Med 1988;16:170–80. https://doi.org/10.1177/036354658801600215.
[9] Shelbourne D, Sullivan NA, Bohard K, Tinker Gray MA, Urch SE. Return to basketball and soccer after anterior cruciate ligament reconstruction in competitive school-aged. Athletes K Sports Health 2009;1(3):236–41. https://doi.org/10.1177/1941738109334275.
[10] Bizzini M, Hancock D, Impellizzeri F. Suggestions from the field for return to sports participation following anterior cruciate ligament reconstruction: soccer. J Orthop Sports Phys Ther 2012;42(4):304–12. https://doi.org/10.2519/jospt.2012.4005.
[11] De Valk EJ, Moen MH, Winters M, Bakker EW, Tamminga R, van der Hoeven H. Preoperative patient and injury factors of successful rehabilitation after anterior cruciate ligament reconstruction with single-bundle techniques. Arthroscopy 2013;29(11):1879–95. https://doi.org/10.1016/j.arthro.2013.07.273. PMID: 24209682.
[12] López Gómez E. El método Delphi en la investigación actual en educación: una revisión teórica y metodológica. Educación XX1 2018;21(1):19–40. https://doi.org/10.5944/educxx1.20169.
[13] Nwachukwu BU, Adjei J, Rauck RC, Chahla J, Okoroha KR, Verma NN, et al. How much do psychological factors affect lack of return to play after anterior cruciate ligament reconstruction? A systematic Review. Orthop J Sports Med 2019;7(5). https://doi.org/10.1177/2325967119845313. PMID: 31205965 PMCID: PMC6537068.
[14] Mayr HO, Weig TG, Plitz W. Arthrofibrosis following ACL reconstruction: reasons and outcome. Arch Orthop Trauma Surg 2004;124(8):518–22. https://doi.org/10.1007/s00402-004-0718-x. PMID: 15480713.
[15] Deabate L, Previtali D, Grassi A, Filardo G, Candrian C, Delcogliano M. Anterior cruciate ligament reconstruction within 3 Weeks does not increase stiffness and complications compared with delayed reconstruction: a meta-analysis of randomized controlled trials. Am J Sports Med 2020;48(5):1263–72. https://doi.org/10.1177/0363546519862294. Epub 2019 Aug 5. PMID: 31381374.
[16] Lepley LK, Palmieri-Smith RM. Pre-operative quadriceps activation is related to post-operative activation, not strength, in patients post-ACL reconstruction. Knee Surg Sports Traumatol Arthrosc 2016;24(1):236–46. https://doi.org/10.1007/s00167-014-3371-0. Epub 2014 Oct 15. PMID: 25315083; PMCID: PMC4758128.
[17] Keays SL, Bullock-Saxton JE, Newcombe P, Bullock MI. The effectiveness of a pre-operative home-based physiotherapy programme for chronic anterior cruciate ligament deficiency. Physiother Res Int 2006;11(4):204–18. https://doi.org/10.1002/pri.341. Erratum in: Physiother Res Int. 2007 Sep;12(3):195. PMID: 17236528.
[18] Eitzen I, Moksnes H, Snyder-Mackler L, Risberg MA. A progressive 5-week exercise therapy program leads to significant improvement in knee function early after anterior cruciate ligament injury. J Orthop Sports Phys Ther 2010;40(11):705–21. https://doi.org/10.2519/jospt.2010.3345. PMID: 20710097; PMCID: PMC3158986.

[19] Giesche F, Niederer D, Banzer W, Vogt L. Evidence for the effects of prehabilitation before ACL-reconstruction on return to sport-related and self-reported knee function: a systematic review. PLoS One 2020 Oct 28;15:e0240192. https://doi.org/10.1371/journal.pone.0240192. PMID: 33112865; PMCID: PMC7592749.

[20] Grindem H, Granan LP, Risberg MA, Engebretsen L, Snyder-Mackler L, Eitzen I. How does a combined preoperative and postoperative rehabilitation programme influence the outcome of ACL reconstruction 2 years after surgery? A comparison between patients in the Delaware-Oslo ACL Cohort and the Norwegian National Knee Ligament Registry. Br J Sports Med 2015 Mar;49:385–9. https://doi.org/10.1136/bjsports-2014-093891. Epub 2014 Oct 28. PMID: 25351782; PMCID: PMC4351141.

[21] Shaarani SR, O'Hare C, Quinn A, Moyna N, Moran R, O'Byrne JM. Effect of prehabilitation on the outcome of anterior cruciate ligament reconstruction. Am J Sports Med 2013 Sep;41:2117–27. https://doi.org/10.1177/0363546513493594. Epub 2013 Jul 11. PMID: 23845398.

[22] Ardern CL, Taylor NF, Feller JA, Webster KE. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. Br J Sports Med 2014 Nov;48:1543–52. https://doi.org/10.1136/bjsports-2013-093398. Epub 2014 Aug 25. PMID: 25157180.

[23] Grindem Hege, Snyder-Mackler Lynn, Moksnes Håvard, Engebretsen Lars, Risberg May Arna. Simple decision rules reduce reinjury risk after anterior cruciate ligament reconstruction: the Delaware-Oslo ACL cohort study. Br J Sports Med. Author manuscript; available in PMC 2017 Jul 1. Br J Sports Med 2016 Jul;50:804–8. https://doi.org/10.1136/bjsports-2016-096031.

[24] Joreitz r, Lynch a, Rabuck s, Lynch b, Davin s, Irrigang j. Patient-specific and surgery-specific factors that affect return to sport after acl reconstruction. Int.J. Sports phys ther. 2016 apr;11:264–78. PMID: 27104060; PMC: PMC4827369.

[25] Franck F, Saithna A, Dutra Vieira T, Pioger C, Vigne G, Le Guen M, et al. Return to sport composite test after anterior cruciate ligament reconstruction(K-STARTS): factors affecting return to sports test score in a retrospective analysis of 676 patients. Sport Health 2021 Jul-Aug;13(4):364–72. Published online 2021 Feb 6. https://doi.org/10.1177/1941738120978240.

[26] Failla MJ, Logerstedt DS, Grindem H, Axe MJ, Risberg MA, Engebretsen L, et al. Does extended preoperative rehabilitation influence outcomes 2 Years after ACL reconstruction? A comparative effectiveness study between the MOON and Delaware-Oslo ACL cohorts. Am J Sports Med 2016 Oct;44:2608–14. https://doi.org/10.1177/0363546516652594. Epub 2016 Jul 14. Erratum in: Am J Sports Med. 2017 Apr;45(5):NP9. PMID: 27416993; PMCID: PMC5537599.

[27] Zore MR, Kregar Velikonja N, Hussein M. Pre- and post-operative limb symmetry indexes and estimated preinjury capacity index of muscle strength as predictive factors for the risk of ACL reinjury: a retrospective cohort study of athletes after ACLR. Appl Sci 2021;11:3498.

[28] 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 May;47:334–8. https://doi.org/10.2519/jospt.2017.7285. Epub 2017 Mar 29. PMID: 28355978; PMCID: PMC5483854.

[29] Gupta PK, Acharya A, Mourya A, Mahajan P. Comparison of patellar tendon versus hamstrings autografts for anterior cruciate ligament reconstruction in Indian population: a randomised control trial study. J Clin Orthop Trauma 2019 May-Jun;10:581–5. https://doi.org/10.1016/j.jcot.2018.04.018. Epub 2018 Apr 27. PMID: 31061594; PMCID: PMC6494777.

[30] Vyas D, Rabuck SJ, Harner CD. Allograft anterior cruciate ligament reconstruction: indications, techniques, and outcomes. J Orthop Sports Phys Ther 2012 Mar;42:196–207. https://doi.org/10.2519/jospt.2012.4083. Epub 2012 Jan 25. PMID: 22282347.

[31] Figueroa D, Figueroa F, Calvo R, Vaisman A, Ahumada X, Arellano S. Platelet-rich plasma use in anterior cruciate ligament surgery: systematic review of the literature. Arthroscopy 2015;31:981–8. https://doi.org/10.1016/j.arthro.2014.11.022.

[32] Gill SS, Diduch DR. Outcomes after meniscal repair using the meniscus arrow in knees undergoing concurrent anterior cruciate ligament reconstruction. Arthroscopy 2002 Jul-Aug;18:569–77. https://doi.org/10.1053/jars.2002.29897. PMID: 12098116.

[33] Kalliakmanis A, Zourntos S, Bousgas D, Nikolaou P. Comparison of arthroscopic meniscal repair results using 3 different meniscal repair devices in anterior cruciate ligament reconstruction patients. Arthroscopy 2008 Jul;24:810–6. https://doi.org/10.1016/j.arthro.2008.03.003.

[34] Smith AH, Capin JJ, Zarzycki R, Snyder-Mackler L. Athletes with bone-patellar tendon-bone autograft for anterior cruciate ligament reconstruction were slower to meet rehabilitation milestones and return-to-sport criteria than athletes with hamstring tendon autograft or soft tissue allograft: secondary analysis from the ACL-SPORTS trial. J Orthop Sports Phys Ther 2020 May;50:259–66. https://doi.org/10.2519/jospt.2020.9111. Epub 2019 Nov 27. PMID: 31775553; PMCID: PMC7196003.

[35] Kaeding CC, Pedroza AD, Reinke EK, Huston L, Hewett T, Moon Knee group, et al. Change in anterior cruciate ligament graft choice and outcomes over time. Arthrosc J Arthrosc Relat Surg 2017:1–8. https://doi.org/10.1016/j.arthro.2017.06.019.

[36] Rowan FE, Huq SS, Haddad FS. Lateral extra-articular tenodesis with ACL reconstruction demonstrates better patient-reported outcomes compared to ACL reconstruction alone at 2 years minimum follow-up. Arch Orthop Trauma Surg 2019 Oct;139:1425–33. https://doi.org/10.1007/s00402-019-03218-3. Epub 2019 Jul 11. PMID: 31297583.

[37] Truong LK, Mosewich AD, Holt CJ, Le CY, Miciak M, Whittaker JL. Psychological, social, and contextual factors across recovery stages following a sport-related knee injury: a scoping review. Br J Sports Med 2020 Oct;54:1149–56. https://doi.org/10.1136/bjsports-2019-101206. Epub 2020 Feb 14. PMID: 32060141; PMCID: PMC7513260.

[38] Mardani-Kivi M, Azari Z, Hasannejad F. Return to sport activity after anterior cruciate ligament reconstruction: a 6–10-year follow-up. J Clin Orthop Trauma 2020 May;11:S319–25. https://doi.org/10.1016/j.jcot.2019.09.023. Epub 2019 Oct 19. PMID: 32523287; PMCID: PMC7275270.

[39] Burgi Ciara R, Peters Scott, Ardern Clare L, Magill John R, Gomez Christina D, Sylvain Jonathan, 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 Sep;53:1154–61. https://doi.org/10.1136/bjsports-2018-099982.

[40] Ebert JR, Edwards P, Preez LD, Furzer B, Joss B. Knee extensor strength, hop performance, patient-reported outcome, and inter-test correlation in patients 9-12 months after anterior cruciate ligament reconstruction. Knee 2021 Jun;30:176–84. https://doi.org/10.1016/j.knee.2021.04.012. Epub 2021 Apr 30. PMID: 33940305.

[41] Petschnig R, Baron R, Albrecht M. The relationship between isokinetic quadriceps strength test and hop tests for distance and one-legged vertical jump test following anterior cruciate ligament reconstruction. J Orthop Sports Phys Ther 1998 Jul;28:23–31. https://doi.org/10.2519/jospt.1998.28.1.23. PMID: 9653687.

[42] Buckthorpe M. Optimising the late-stage rehabilitation and return-to-sport training and testing process after ACL reconstruction. Sports Med 2019 Jul;49:1043–58. https://doi.org/10.1007/s40279-019-01102-z. PMID: 31004279.

[43] Buckthorpe M, Della Villa F. Recommendations for plyometric training after ACL reconstruction - a clinical commentary. Int J Sports Phys Ther 2021 Jun 1;16:879–95. https://doi.org/10.26603/001c.23549. PMID: 34123540; PMCID: PMC8169025.

[44] Buckthorpe M, Della Villa F. Optimising the 'mid-stage' training and testing process after ACL reconstruction. Sports Med 2020 Apr;50:657–78. https://doi.org/10.1007/s40279-019-01222-6. PMID: 31782065.

[45] Ardern CL, Taylor NF, Feller JA, Whitehead TS, Webster KE. Psychological responses matter in returning to preinjury level of sport after anterior cruciate ligament reconstruction surgery. Am J Sports Med 2013 Jul;41:1549–58. https://doi.org/10.1177/0363546513489284. Epub 2013 Jun 3. PMID: 23733635.

[46] Paterno MV, Huang B, Thomas S, Hewett TE, Schmitt LC. Clinical factors that predict a second ACL injury after ACL reconstruction and return to sport: preliminary development of a clinical decision algorithm. 2325967117745279 Orthop J Sports Med 2017 Dec 19;5. https://doi.org/10.1177/2325967117745279. PMID: 29318172; PMCID: PMC5753959.

[47] Wiggins AJ, Grandhi RK, Schneider DK, Stanfield D, Webster KE, Myer GD. Risk of secondary injury in younger athletes after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Am J Sports Med 2016 Jul;44:1861–76. https://doi.org/10.1177/0363546515621554. Epub 2016 Jan 15. PMID: 26772611; PMCID: PMC5501245.

[48] Courtot L, Ferre F, Reina N, Marot V, Chiron P, Berard E, et al. Patient participation during anterior cruciate ligament reconstruction improves comprehension, satisfaction, and functional outcomes: a simple way to improve our practices. 2325967119841089 Orthop J Sports Med 2019 Apr 29;7. https://doi.org/10.1177/2325967119841089. PMID: 31065554; PMCID: PMC6488790.

[49] DeFroda SF, ODonnell RM, Fadale PD, Owens BD, Fleming BC. The role of magnetic resonance imaging in evaluating postoperative ACL reconstruction healing and graft mechanical properties: a new criterion for return to play? Phys Sportsmed 2021 May;49:123–9. https://doi.org/10.1080/00913847.2020.1820846. Epub 2020 Sep 30. PMID: 32897799; PMCID: PMC8007665.

[50] Lutz Patricia M, Achtnich Andrea, Vincent Schütte, Woertler Klaus, Imhoff Andreas B, Willinger Lukas. Anterior cruciate ligament autograft maturation on sequential postoperative MRI is not correlated with clinical outcome and anterior knee stability. Knee Surg Sports Traumatol Arthrosc 2022;(10):3258–67. https://doi.org/10.1007/s00167-021-06777-4. PMID: 34739559 PMCID: PMC9464175.

[51] Ardern CL, Österberg A, Tagesson S, Gauffin H, Webster KE, Kvist J. The impact of psychological readiness to return to sport and recreational activities after anterior cruciate ligament reconstruction. Br J Sports Med 2014 Dec;48:1613–9. https://doi.org/10.1136/bjsports-2014-093842. Epub 2014 Oct 7. PMID: 25293342.

[52] Zwolski C, Schmitt LC, Quatman-Yates C, Thomas S, Hewett TE, Paterno MV. The influence of quadriceps strength asymmetry on patient-reported function at time of return to sport after anterior cruciate ligament reconstruction. Am J Sports Med 2015 Sep;43:2242–9. https://doi.org/10.1177/0363546515591258. Epub 2015 Jul 16. PMID: 26183172.

[53] Queen RM, Peebles AT, Miller TK, Savla J, Ollendick T, Messier SP, et al. Reduction of risk factors for ACL Re-injuries using an innovative biofeedback approach: rationale and design. Contemp Clin Trials Commun 2021 Apr 20;22:100769. https://doi.org/10.1016/j.conctc.2021.100769. PMID: 33997461; PMCID: PMC8100073.

[54] Webster KE, Hewett TE. Is there value and validity for the use of return to sport test batteries after anterior cruciate ligament injury and reconstruction? Arthroscopy 2020 Jun;36:1500–1. https://doi.org/10.1016/j.arthro.2020.03.025. Epub 2020 Apr 4. PMID: 32259646.

[55] Kim SG, Kurosawa H, Sakuraba H, Ikeda H, Takazawa S. The effect of initial graft tension on postoperative clinical outcome in anterior cruciate ligament reconstruction with smitendinosus tendon. Arch Orthop Trauma Surg 2006;126:260–4. https://doi.org/10.1007/s00402-005-0045-x.

[56] Yasuda K, Tsujino J, Tanabe Y, Kaneda K. Effects of initial graft tension on clinical outcome after anterior cruciate ligament reconstruction. Autogenous double-hamstring tendons connected in series with polyester tapes. Am J Sports Med 1997;25:99–106. https://doi.org/10.1177/036354659702500120.

[57] Katsuragi R, Yasuda K, Tsujino J, Keira M, Kaneda K. The effect of nonphysiologically high initial tension on the mechanical properties of in situ frozen anterior cruciate ligament in a canine model. Am J Sports Med 2000;28:47–56. https://doi.org/10.1177/03635465000280012001. PMID: 10653543.

[58] Brophy RH, Zelster D, Wright RW, Flanigan D. Anterior cruciate ligament reconstruction and articular cartilage Injury: incidence and treatment. Arthroscopy 2010;26:112–20. https://doi.org/10.1016/j.arthro.2009.09.002. PMID: 20117635.

[59] Shelbourne K, Gray T. Results of anterior cruciate ligament reconstruction based on meniscus and articular cartilage status at the time of surgery. Five-to-fifteen-year evaluations. Am J Sports Med 2000;28:446–52. https://doi.org/10.1177/03635465000280040201. PMID: 10921633.

[60] Read P, Mc Auliffe S, Wilson MG, Myer GD. Better reporting standards are needed to enhance the quality of hop testing in the setting of ACL return to sport decisions: a narrative review. Br J Sports Med 2021 Jan;55(1):23–9. https://doi.org/10.1136/bjsports-2019-101245. Published online 2020 Jun 10 PMID: 32522734 PMCID: PMC7788201.

[61] Losciale JM, Zdeb RM, Ledbetter L, Reiman MP, Sell TC. The association between passing return-to-sport criteria and second anterior cruciate ligament injury risk: a systematic review with metaanalysis. J Orthop Sports Phys Ther 2019;49:4354. https://doi.org/10.2519/jospt.2019.8190. pmid, http://www.ncbi.nlm.nih.gov/pubmed/30501385.

[62] Webster KE, Hewett TE. What is the evidence for and validity of Return-to-Sport testing after anterior cruciate ligament reconstruction surgery? A systematic review and meta-analysis. Sports Med 2019;49:917–29. https://doi.org/10.1007/s40279-019-01093x. pmid, http://www.ncbi.nlm.nih.gov/pubmed/30905035.

[63] Faleide AGH, Magnussen LH, Strand T, Bogen BE, Moe-Nilssen R, Mo Ingunn Fleten, et al. The role of psychological readiness in return to sports assessment after anterior cruciate ligament reconstruction. Am J Sports Med 2021 Apr;49(5):1236–43. https://doi.org/10.1177/0363546521991924. Published online 2021 Mar 3. PMID: 33656938 PMCID: PMC8020301.

[64] Hong L, Chen J, Li H, Wu Z, Chen S. MRI-based ACL graft maturity does not predict clinical and functional outcomes during the first year after ACL reconstruction. Knee Surg Sports Traumatol Arthrosc 2017 Oct;25(10):3171–8. https://doi.org/10.1007/s00167-016-4252-5. Epub 2016 Aug 2 PMID: 27485123.

[65] Nagelli Christopher V, Hewett TE. Should return to sport be delayed until two years after anterior cruciate ligament reconstruction? Biological and functional considerations. Sports Med 2017 Feb;47(2):221–32. https://doi.org/10.1007/s40279-016-0584-z.

[66] Shelbourne KD, Wilckens JH, Mollabashy A, DeCarlo M. Arthrofibrosis in acute anterior cruciate ligament reconstruction. The effect of timing of reconstruction and rehabilitation. Am J Sports Med 1991 Jul-Aug;19(4):332–6. https://doi.org/10.1177/036354659101900402. PMID: 1897645.

[67] Mayr HO, Weig TG, Plitz W. Arthrofibrosis following ACL reconstruction–reasons and outcome. Arch Orthop Trauma Surg 2004 Oct;124:518–22. https://doi.org/10.1007/s00402-004-0718-x. PMID: 15480713.

[68] Bottoni CR, Liddell TR, Trainor TJ, Freccero DM, Lindell KK. Postoperative range of motion following anterior cruciate ligament reconstruction using autograft hamstrings: a prospective, randomized clinical trial of early versus delayed reconstructions. Am J Sports Med 2008;36(4):656–62. https://doi.org/10.1177/0363546507312164. PMID: 18212347.

[69] Shaarani SR, O'Hare C, Quinn A, Moyna N, Moran R, O'Byrne JM. Effect of prehabilitation on the outcome of anterior cruciate ligament reconstruction. Am J Sports Med 2013;41(9):2117–27. https://doi.org/10.1177/0363546513493594. PMID: 23845398.

[70] Eriksson K, von Essen C, Jonhagen S, Barenius B. No risk of arthrofibrosis after acute anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2018;26(10):2875–82. https://doi.org/10.1007/s00167-017-4814-1. PMID: 29188336 PMCID: PMC6154043.

[71] Haro MS, Shelbourne KD. Prevention and management of loss of motion in anterior cruciate ligament surgery. Oper Tech Sports Med 2016;24:45–54. https://doi.org/10.1053/j.otsm.2015.09.004.

[72] Eitzen, I Holm, M A Risberg. Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. Br J Sports Med. 2009;43(5);371-376 https://doi.org/10.1136/bjsm.2008.057059.

[73] Marco Bigoni, Marco Turati, Marta Gandolla,Paola Sacerdote,Massimiliano Piatti, Alberto Castelnuovo,Silvia Franchi, Massimo Gorla, Daniele Munegato, Diego Gaddi,Alessandra Pedrocchi, Robert J. Omeljaniuk, Vittorio Locatelli, and Antonio Torsello Effects of ACL Reconstructive Surgery on Temporal Variations of Cytokine Levels in Synovial Fluid Volume 2016. https://doi.org/10.1155/2016/8243601.

[74] Anderson MJ, Browning WM, Urband CE, Kluczynski MA, Bisson LJ. A systematic summary of systematic reviews on the topic of the anterior cruciate ligament. Orthop J Sport Med 2016;4:23. https://doi.org/10.1177/2325967116634074.

[75] Van Melick N, Van Cingel RE, Brooijmans F, Neeter C, Van Tienen T, Hullegie W, et al. Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. Br J Sports Med 2016;50:1506–15. https://doi.org/10.1136/bjsports-2015-095898.

[76] Alshewaier S, Yeowell G, Fatoye F. The effectiveness of pre-operative exercise physiotherapy rehabilitation on the outcomes of treatment following anterior cruciate ligament injury: a systematic review. Clin Rehabil 2017;31:3444. https://doi.org/10.1177/0269215516628617.

[77] DeFazio MW, Curry EJ, Gustin MJ, Sing DC, Abdul-Rassoul H, Ma R, et al. Return to sport after ACL reconstruction with a BTB versus hamstring tendon autograft: a systematic review and meta-analysis. Orthop J Sports Med 2020 Dec;8(12). https://doi.org/10.1177/2325967120964919. 2325967120964919. Published online 2020 Dec 15.

[78] Xie X, Liu X, Chen Z, Yu Y, Peng S, Li Q. A meta-analysis of bone-patellar tendon-bone autograft versus four-strand hamstring tendon autograft for anterior cruciate ligament reconstruction. Knee 2015 Mar;22:100–10. https://doi.org/10.1016/j.knee.2014.11.014.

[79] Goetz G, de Villiers C, Sadoghi P, Geiger-Gritsch S. Allograft for anterior cruciate ligament reconstruction (ACLR): a systematic review and meta-analysis of long-term comparative effectiveness and safety. Results of a health technology assessment. Arthrosc Sports Med Rehab 2020;2(6):e873–91. https://doi.org/10.1016/j.asmr.2020.07.003. PMID: 33376999 PMCID: PMC7754611.

[80] Hevesi M, LaPrade M, Saris DBF, Krych AJ. Stem cell treatment for ligament repair and reconstruction. Curr Rev Musculoskelet Med 2019 Dec;12:446–50. https://doi.org/10.1007/s12178-019-09580-4. Published online 2019 Oct 17. PMID: 31625113 PMCID: PMC6942090.

[81] Balasingam S, Sernert N, Magnusson H, Kartus J. Patients with concomitant intra-articular lesions at index surgery deteriorate in their knee injury and osteoarthritis outcome score in the long term more than patients with isolated anterior cruciate ligament rupture: a study from the Swedish national anterior cruciate ligament register. Arthroscopy 2018;34:1520–9. https://doi.org/10.1016/j.arthro.2017.11.019.

[82] Lutz C. Role of anterolateral reconstruction in patients undergoing anterior cruciate ligament reconstruction. J Orthop Traumatol: Surgery & Research February 2018;104:S47–53. https://doi.org/10.1016/j.otsr.2017.03.031.

[83] Cavanaugh JT, Powers M. ACL rehabilitation progression: where are we now? Curr Rev Musculoskelet Med 2017;10(3):289–96. https://doi.org/10.1007/s12178-017-9426-3. Published online 2017 Aug 8. PMID: 28791612 PMCID: PMC5577427.

[84] Sonesson S, Kvist J, Ardern C, Österberg A, Silbernagel KG. Psychological factors are important to return to pre-injury sport activity after anterior cruciate ligament reconstruction: expect and motivate to satisfy. Knee Surg Sports Traumatol Arthrosc 2017;25(5):1375–84. https://doi.org/10.1007/s00167-016-4294-8.

[85] Swain MS, Henschke N, Kamper SJ, Downie AS, Koes BW, Maher CG. Accuracy of clinical tests in the diagnosis of anterior cruciate ligament injury: a systematic review. Chiropr Man Ther 2014;22(Aug):25. https://doi.org/10.1186/s12998-014-0025-8. Article number: 25 (2014).

[86] Abrams GD, Harris JD, Gupta AK, McCormick FM, Bush-Joseph CA, Verma NN, et al. Functional performance testing after anterior cruciate ligament reconstruction A systematic review. M Orthop J Sports Med 2014;2(1). https://doi.org/10.1177/2325967113518305. 2325967113518305. Published online 2014 Jan 21. PMID: 26535266 PMCID: PMC4555525.

[87] Davies WT, Myer GD, Read PJ. Is it time we better understood the tests we are using for return to sport decision making following ACL reconstruction? A critical review of the hop tests. Sports Med 2020;50:485–95. https://doi.org/10.1007/s40279-019-01221-7.

[88] Sinacore JA, Evans AM, Lynch BN, Joreitz RE, Irrgang JJ, Lynch AD. Diagnostic accuracy of handheld dynamometry, and 1-Repetition-maximum tests for identifying meaningful quadriceps strength asymmetries. J Orthop Sports Phys Ther 2017;47(2):97–107. https://doi.org/10.2519/jospt.2017.6651. PMID: 28142362.

[89] Edwards PK, Ebert JR, Joss B, Ackland T, Annear P, Buelow J-U, et al. Patient characteristics and predictors of return to sport at 12 Months after anterior cruciate ligament reconstruction: the importance of patient Age and postoperative rehabilitation. Orthop J Sports Med 2018;6(9). https://doi.org/10.1177/2325967118797575. 2325967118797575. Published online 2018 Sep 20. PMID: 30263898 PMCID: PMC6149022.

[90] Burland JP, Kostyun RO, Kostyun KJ, Solomito M, Nissen C, Milewski MD. Clinical outcome measures and return-to-sport timing in adolescent athletes after anterior cruciate ligament reconstruction. J Athl Train 2018;53(5):442–51. https://doi.org/10.4085/1062-6050-302-16. PMID: 29847160 PMCID: PMC6107766.

[91] Barber-Westin SD, Noyes FR. Review Factors used to determine return to unrestricted sports activities after anterior cruciate ligament reconstruction. Arthroscopy 2011;27(12):1697–705. https://doi.org/10.1016/j.arthro.2011.09.009.

[92] Welling W, Benjaminse A, Lemmink K, Gokeler A. Passing return to sports tests after ACL reconstruction is associated with greater likelihood for return to sport but fail to identify second injury risk. Knee 2020;27(3):949–57. https://doi.org/10.1016/j.knee.2020.03.007. PMID: 32247810.

[93] Skulmoski GJ, Hartman FT, Krahn J. The Delphi method for graduate research. J Info Tech Edu 2007;6(1):1–21. https://doi.org/10.28945/199.

[94] von der Gracht H. Consensus measurement in Delphi studies Review and implications for future quality assurance. Technol Forecast Soc Change 2012;79:1525–36. https://doi.org/10.1016/j.techfore.2012.04.013.

[95] Andrade R, Pereira R, van Cingel R, Staal JB, Espregueira-Mendes J. How should clinicians rehabilitate patients after ACL reconstruction? A systematic review of clinical practice guidelines (CPGs) with a focus on quality appraisal (AGREE II). Br J Sports Med 2020;54:512–9. https://doi.org/10.1136/bjsports-2018-100310.

[96] Getgood AM, Bryant D, Litchfield RB, McCormack RG, Heard M, MacDonald PB, et al., Stability Study Group. Lateral extra-articular tenodesis reduces failure of hamstring tendon autograft ACL reconstruction -two year outcomes from the STABILITY study randomized clinical trial. Orthop J Sports Med 2019 Jul;7(7 suppl 5). https://doi.org/10.1177/2325967119S00280. Published online 2019 Jul 29.

[97] Welling W, Benjaminse A, Lemmink K, Dingenen B, Gokeler A. Progressive strength training restores quadriceps and hamstring muscle strength within 7 months after ACL reconstruction in amateur male soccer players. Phys Therapy Sport 2019 Nov;40:10–8. https://doi.org/10.1016/j.ptsp.2019.08.004. Epub 2019 Aug 9.

[98] Losciale UM, Zdeb RM, Ledbetter L, Reiman MP, Sell TC. The association between passing return-to-sport criteria and second anterior cruciate ligament injury risk: a systematic review with meta-analysis. J Orthop Sports Phys Ther February 2019;49(2):43–54. https://doi.org/10.2519/jospt.2019.8190. PMID: 30501385.

[99] Huang W, Zhang Y, Yao Z, Ma L. Clinical examination of anterior cruciate ligament rupture: a systematic review and meta-analysis. Acta Orthop Traumatol Turcica 2016;50(1):22–31. https://doi.org/10.3944/AOTT.2016.14.0283. PMID: 26854045.