



# Time for a Different Approach to Anterior Cruciate Ligament Injuries: Educate and Create Realistic Expectations

Joshua Robert Zadro<sup>1,2</sup> · Evangelos Pappas<sup>3</sup>

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## Abstract

Following an anterior cruciate ligament (ACL) injury, patients are often reassured that timely surgery followed by intensive physiotherapy will “fix their knee”. Not only does this message create a false perception of uncomplicated return to sport (RTS), it also ignores the large body of evidence demonstrating a high RTS re-injury rate following ACL reconstruction. In this article, we propose an individualised approach to the management of ACL injuries that targets a shift away from early surgery and towards conservative management, with surgery ‘as needed’ and rehabilitation tailored to the patient’s RTS goals. Education on the natural history of ACL injuries will ensure patients are not misguided into thinking surgery and intensive rehabilitation guarantees great outcomes. Further, understanding that conservative management is not inferior to surgery—and not more likely to cause knee osteoarthritis—will help the patient make an informed decision. For patients who opt for surgical management, rehabilitation must target strength and functional performance, avoid rapid increases in training load, and be guided by an RTS timeframe that is no shorter than 9 months. The content of rehabilitation should be similar for patients who opt for non-operative management, although the RTS timeframe will likely be shorter. All patients should receive education on the relationship between injury risk and training load, and understand that a home-exercise program is not inferior to intensive physiotherapist-led exercise.

## Key Points

Education on the natural history of anterior cruciate ligament (ACL) injuries will ensure patients are not misguided into thinking surgery and intensive rehabilitation will “fix their knee”.

Patients need to be aware that conservative management of ACL injuries (with surgery ‘as needed’) is not inferior to early surgery for improving symptoms, function, quality of life, and sports participation, and the likelihood of developing knee osteoarthritis is no different between either approach.

Rehabilitation must target strength and functional performance, avoid rapid increases in training load, and be guided by a return to sport (RTS) timeframe that is no shorter than 9 months (postoperative rehabilitation only).

Home-exercise is not inferior to physiotherapist-led rehabilitation following ACL reconstruction, but there is no research comparing home exercise to physiotherapist-led rehabilitation following non-operative management.

The level of physiotherapist supervision during rehabilitation should nevertheless be dictated by the patient’s preferences, resources and RTS goals.

✉ Joshua Robert Zadro  
joshua.zadro@sydney.edu.au

<sup>1</sup> School of Public Health, Sydney Medical School, The University of Sydney, C39-Level 10 North, King George V Building, Royal Prince Alfred Hospital, Missenden Road, PO Box M179, Sydney, NSW 2050, Australia

<sup>2</sup> Institute for Musculoskeletal Health, Sydney Local Health District, Sydney, NSW, Australia

<sup>3</sup> Discipline of Physiotherapy, Faculty of Health Sciences, The University of Sydney, Lidcombe, NSW, Australia

## 1 Introduction

Patients wanting to return to sports (RTS) after an anterior cruciate ligament (ACL) injury are commonly recommended anterior cruciate ligament reconstruction (ACLR) [1]. Thus, the annual incidence of ACLR continues to rise [2–4], particularly for younger patients and those seeking revision surgery [2]. Unfortunately, only 65% of patients return to their pre-injury level of sports participation following ACLR [5], and of those who do, nearly one in four experience a subsequent ACL injury [6]. This raises concerns about the appropriateness of current surgical and rehabilitation strategies.

Patients are often reassured that timely surgery followed by intensive rehabilitation will “fix their knee”, but it is this message that creates a false perception that the patient with the ‘best’ surgeon and ‘best’ physiotherapist will experience RTS without complications. Outcomes following ACLR—even with intensive postoperative rehabilitation—are far from inspiring [2]. It is, therefore, vitally important to educate patients and create expectations that are consistent with current evidence. The modest outcomes following ACLR should also prompt the sports medicine community to consider whether it is time to start promoting non-operative management or delayed surgery (hereafter referred to as ‘conservative management’) as first-line treatment, as in some Scandinavian countries [7, 8].

In this article, we propose an individualised approach to the management of ACL injuries. This approach prioritises education on the natural history of ACL injuries (including the high RTS re-injury rate after ACLR), the benefits of conservative management, and the necessary components of rehabilitation if the patient desires to RTS. Through appropriate education and shared decision making, this approach targets a shift from the traditional management of ACL injuries—often overemphasising the value of early surgery and supervised rehabilitation—and towards conservative management with surgery ‘as needed’ and rehabilitation tailored to the patient’s RTS goals.

## 2 The Natural History of Anterior Cruciate Ligament (ACL) Injuries

Patients largely do not understand the seriousness of an ACL injury, with 91% expecting to RTS at their pre-injury level following ACLR and 98% expecting little to no increase in their risk of developing knee osteoarthritis within the next 10 years [9]. Unfortunately, RTS following ACLR is not without its complications and nearly one in four patients experience a subsequent knee injury following RTS [6]. Further, approximately 40% of patients develop radiographic

knee osteoarthritis 14–15 years following an ACL injury [10, 11]. Misguided expectations among patients likely stem from the belief that surgery—followed by rehabilitation—will “fix their knee” and guarantee uncomplicated RTS. Misguided faith in operative management places the onus on the surgeon and rehabilitation provider (often a physiotherapist) to ensure the patient achieves optimal outcomes. However, this ‘overmedicalisation’ of ACL injuries neglects the patient’s role in the decision-making process; a problem that is exemplified when a patient experiences multiple re-injuries yet still pursues surgical management to “fix their knee”.

Following re-injury, some surgeons and physiotherapists try to reassure the athlete by justifying their re-injury as ‘unlucky’ or due to a ‘rare’ graft failure, while others suggest surgical error or lack of proper rehabilitation. These messages could reassure the patient by making them feel like the injury was not their fault, but could just as easily give them false hope that a different surgical procedure or rehabilitation protocol is going to result in better outcomes next time. Even though surgical error and improper rehabilitation could play a role, current evidence suggests that the re-injury rate is high even with the best surgeons and optimal rehabilitation [12]. If patients understood this, they might have thought twice about surgical management in the first place. Unfortunately, this message is often lost when providers overstate the benefits of surgery followed by rehabilitation.

Promising better outcomes with a different surgery or rehabilitation protocol also neglects education on the long-term harms of repeat traumatic knee injuries and benefits of pursuing alternative activities with lower risk of injury. A qualitative study found that people who avoided RTS and adopted a sedentary lifestyle due to fear of re-injury reported poor quality of life in the long term [13]. Appropriate education could therefore be important for preventing the cascade of negative health consequences that occur when an injured (and particularly re-injured) patient fears subsequent injury and completely gives up on any athletic activity. However, research is needed to support the effectiveness of education in this context.

Informing patients that surgery and intensive rehabilitation do not guarantee great outcomes should be the cornerstone of ACL injury management, as it will ensure patients have realistic expectations and are able to make an informed choice about their treatment. However, we acknowledge that it might be difficult for surgeons and physiotherapists to deliver these messages, as the patient might perceive inexperience or lack of skill as the reason their clinician is downplaying the effects of surgery or rehabilitation. This again highlights the problem of overmedicalising the management of ACL injuries, since patients will then search for providers with greater belief in their ability to guarantee optimal outcomes.

### 3 Conservative versus Surgical Management

The above points should not be misinterpreted as suggesting non-operative management is the golden ticket for patients wanting to RTS—far from it. Neither surgical nor conservative management will guarantee uncomplicated RTS, but there is now strong evidence that conservative management of ACL injuries does not result in inferior outcomes compared to surgery. A randomised controlled trial involving 121 patients compared early ACLR to conservative management (with an option for delayed surgery) and found no between-group differences in knee symptoms, function, quality of life, sports participation or radiographic knee osteoarthritis at 5-year follow-up [14]. To further strengthen the argument that conservative management is not inferior to surgery, rehabilitation alone was a predictor of greater improvements in self-reported knee symptoms at 5 years (10 points fewer out of 100, 95% confidence interval (CI) 2–18) [15].

Inclusion of the option for delayed surgery in the above study [14] makes it difficult to assess the necessity of ACLR for patients who wish to RTS, particularly for sports involving pivoting and cutting. However, more than half of those initially assigned to non-operative management elected to undergo ACLR. This highlights the difficulty of conducting a randomised controlled trial that compares surgery to non-operative management [14].

#### 3.1 What Drives Patients to Surgery?

The reasons patients opt for delayed surgery suggest many do not cope with non-operative management. In the randomised controlled trial by Frobell et al. [16], participants wanting delayed surgery needed to experience episodes of ‘giving-way’ (caused by ACL insufficiency) and have a positive pivot shift test, or present with instability of another cause (meniscus tear or loose body) that was confirmed by a second opinion and magnetic resonance imaging (MRI). Further, interviews with participants ( $n = 22$ ) found that many opted for delayed surgery because they were ‘severely’ or ‘extremely’ concerned about the lack of confidence in their knee or experienced subsequent knee trauma [17].

The interviews also found that unrealistic expectations about recovery and prior beliefs drew many participants to surgery, which suggests the high percentage of participants who crossed over to surgery (51%) might be explained by more than participants being ‘non-copers’. Many participants opted for delayed surgery because they found rehabilitation too time consuming and boring, were not satisfied with their initial non-operative outcomes, and believed that they would not reach their full potential or return to

their pre-injury level of sports participation if they did not have surgery. Many also had a strong preference for surgery, joined the trial to avoid long waiting lists, and were not aware that non-operative management was a viable treatment option [17].

Fear of further damage to an ACL-deficient knee was another concern that drew participants to surgery [17]. The ACL prevents excessive anterior translation and rotation of the knee joint, so many clinicians argue early ACLR is needed to protect the meniscus from further damage and prevent osteoarthritis, especially for patients returning to high-level sports. However, there is no evidence to support the concern that patients who RTS on an ACL-deficient knee are at greater risk of osteoarthritis. Approximately 40% will develop knee osteoarthritis 12–14 years following an ACL injury [10, 11, 18], with no difference between those who undergo ACLR or opt for non-operative management (even up to 20 years’ follow-up) [19]. Some studies even show a higher rate of knee osteoarthritis in those who undergo ACLR [18], which might be confounded by athletes often returning to sports involving pivoting and cutting following ACLR. However, this is challenged by a longitudinal study ( $n = 164$ ) that found returning to pivoting sports following ACLR decreased the risk of developing symptomatic (odds ratio (OR) 0.28, 95% CI 0.09–0.89) and radiographic knee osteoarthritis (OR 0.40, 95% CI 0.17–0.98) at 15 years’ follow-up [20].

There are likely many factors that influence patients’ beliefs about the effectiveness of surgery and concerns about non-operative management, such as information from healthcare providers, media coverage of professional athletes who RTS following ACLR, or simply being part of a culture that promotes ‘more’ is ‘better’ in healthcare. In addition, the majority of patients receiving ACLR (84%) obtain information about the procedure from the internet [21], likely reinforcing beliefs about the effectiveness of surgery. A greater understanding of what drives these beliefs will have important implications for communicating the benefits and harms of different treatment options to patients, and warrants more research attention.

#### 3.2 Predicting Responders to Early Surgery and Conservative Management

Predicting who will respond more favourably to early ACLR or non-operative management is the ‘holy grail’ of ACL injury management. However, validating sub-groups of patients likely to respond to early ACLR or non-operative management will be challenging. Sub-groups need to be pre-specified and tested in large randomised controlled trials, with the sample size required to investigate a subgroup effect estimated to be four times larger than a trial of a main effect [22]. There also needs to be evidence that

these sub-groups respond more favourably to treatment that matches their sub-group compared to treatment that opposes their sub-group. For example, participants in the ‘early ACLR’ sub-group will need to respond more favourably to early ACLR than conservative/non-operative management.

Hurd et al. [23] provide an example of a treatment algorithm that has a sound theoretical basis but is yet to be validated (i.e. we do not know if patients managed according to this algorithm do better than those who are not). Therefore, in the absence of evidence that baseline characteristics can be used to match patients to early ACLR or conservative management, outlining the benefits and risks of each approach will help patients make an informed decision about which treatment option is most appropriate for them.

## 4 Rehabilitation

There is no doubt that rehabilitation following an ACL injury is important—regardless of whether a patient opts for conservative management or early ACLR [24]. The components of rehabilitation that are considered necessary together with those that are arguably of lesser importance are outlined in the following sections. This information should help clinicians tailor rehabilitation to a patient’s RTS goals and preferences, while avoiding overtreatment.

### 4.1 What is Necessary for Postoperative Rehabilitation?

#### 4.1.1 Time

The benefits of delaying RTS are clear and there has been a considerable shift away from rehabilitation programs targeting an early RTS—sometimes as early as 6 months [25]. This is because for each month RTS is delayed (until 9 months) the risk of re-injury halves [26] and patients are given more time to pass RTS criteria that reduce the risk of re-injury (e.g. limb symmetry index (LSI) scores > 90%). Failing knee strength, hop performance and agility test criteria, as well as not completing a sports-specific rehabilitation program, increase the risk of re-injury by 400% [27]. This is particularly important for patients wishing to return to sports that involve pivoting and cutting, as they are already four times more likely to experience re-injury [26].

Time is strongly correlated with passing RTS criteria following ACLR [26], with some outcomes taking longer than 9 months to reach key performance milestones [28]. For example, a prospective study ( $n=62$ ) found that ~50% patients achieve LSI scores for knee extension strength that are > 90% at 9 months following ACLR [29]. Similarly, a systematic review of 88 studies ( $n=4927$ ) found a large difference in the proportion of patients who pass RTS criteria

for quadriceps and hamstring strength between 6 months and 12 months, with most studies reporting average LSI scores for quadriceps strength that are < 80% at 6 months [30]. Understanding that patients rarely pass RTS criteria following ACLR before 9 months is particularly valuable for clinicians who do not have access to equipment that can accurately measure strength and functional performance. This supports the decision to impose a minimal RTS timeframe of at least 9 months for patients returning to high-risk sports.

Some experts suggest delaying RTS for up to 2 years in patients involved in high-risk sports. This is on the basis of ongoing biological restoration (bone mineral density, proprioception and graft maturation), recovery of pre-injury strength and functional performance [28], and a ~20% reduction in the risk for re-injury attributed to aging (older patients are at lower risk of re-injury) [31]. However, such a delay could significantly affect a patient’s athletic career and should be taken into consideration when deciding on the best postoperative rehabilitation approach.

#### 4.1.2 Targeting Strength and Functional Performance

The primary goal of rehabilitation for patients wishing to RTS is to restore pre-injury knee function and reduce the risk of re-injury by reaching key milestones for strength and functional performance. Therefore, beyond the minimal RTS timeframe, passing strength and performance test criteria should be a key factor in deciding when a patient can RTS. To address strength and performance deficits appropriately, rehabilitation must provide sufficient training volume and intensity (i.e. training load) to drive strength adaptations and improvements in performance. Van Melick et al. [24] provide guidance on postoperative exercise selection and timeframes for progression, with key elements consisting of quadriceps strengthening and functional performance testing. Further, adding structured agility and jump-landing drills—to resistance training and graded activity—enhance improvements in strength and hop test performance [32], while addressing biomechanical deficits linked to ACL injury may be an important part of preventing re-injury [33, 34]. Despite all this, the optimal dosage and progression of rehabilitation following ACLR remains unknown, with protocols of different intensities and durations equally efficacious for improving function, proprioception, quality of life and sports participation [35]. This means the progression of rehabilitation is largely informed by guidelines [24] and dictated by the preference of the treatment provider.

Research on the relationship between injury risk and the acute:chronic training load could provide further guidance on the safe progression of exercises during rehabilitation [36]. Weekly training loads that drastically exceed a patient’s average training load over the preceding 4 weeks increase the risk of injury [36]. For example, the absolute difference in



injury risk between an acute:chronic training load of 1.7 and 2.0 is nearly 5%, which equates to an increase in the relative risk of almost 40% [36]. With this in mind, monitoring training loads could be invaluable during rehabilitation, particularly when patients reach milestones that greatly increase their enthusiasm for training (e.g. returning to straight-line running, training with their team). To avoid rapid increases in training load, the rehabilitation program should be pre-planned and make full use of the agreed upon RTS timeframe. Further, educating patients on the relationship between injury risk and training load will facilitate greater independence in how they progress their rehabilitation and potentially decrease the likelihood patients progress their rehabilitation too rapidly.

In summary, the progression of a postoperative rehabilitation program that targets strength and functional performance should be guided by an agreed upon RTS timeframe with the patient, provided RTS is no earlier than 9 months and rapid increases in training load are avoided. If the patient decides to pursue activities with a lower risk of injury (e.g. running, cycling, swimming), the progression of rehabilitation will be more straightforward and could be based on simple education about how to progress training load safely. For example, consider a patient previously involved in a pivoting or cutting sport, such as football (soccer), who undergoes ACLR. If the patient decides to pursue long-distance running (and not return to football) there will be less emphasis on the performance of pivoting, cutting, jumping and other activities that are essential components of football, and more emphasis on minimal intervention that includes education on how to sensibly progress running mileage.

#### 4.2 What is Necessary for Non-operative Rehabilitation?

There is considerably more research investigating rehabilitation approaches following ACLR than following non-operative management. Nevertheless, a review by Paterno [37] proposed that the content of non-operative rehabilitation should be similar to post-operative rehabilitation. That is, rehabilitation must involve strengthening (primarily of the quadriceps and hamstring muscles), neuromuscular or perturbation training, a graded progression towards sport-specific activities, and be guided by passing strength and functional performance criteria (LSI scores > 90%) [37]. This approach to rehabilitation should also be considered for patients considering delayed ACLR, as pre-operative quadriceps strength is an important predictor of short- and long-term function following ACLR [38, 39].

The primary difference in the approach to non-operative and post-operative rehabilitation is the RTS timeframe. A randomised controlled trial ( $n = 42$ ) demonstrated that

patients with an ACL-deficient knee undergoing a rehabilitation program involving strengthening and neuromuscular training could reach RTS strength and hop performance criteria approximately 5 months after their injury [40]. Conversely, there are no data that patients can achieve these milestones in such a short period following ACLR. This is likely explained by longer recovery timeframes due to surgical trauma. Therefore, for patients undergoing non-operative rehabilitation, meeting strength and performance criteria could guide RTS decisions without a minimal RTS timeframe.

#### 4.3 Is the Level of Supervision Important?

Physiotherapists are in a great position to help patients optimise their outcomes following ACL injuries as they can implement effective rehabilitation programs and provide appropriate education. However, to ensure rehabilitation best serves the patient's needs, physiotherapists must consider the patient's RTS goals, preferences for rehabilitation, and logistics, such as access to physiotherapy and cost.

A recent observational study demonstrated a positive correlation between the amount of supervised rehabilitation and performance measures in patients following ACLR, concluding that many patients do not receive adequate 'supervised' rehabilitation [32]. Grindem et al. [41] used this paper to present a similar argument, but it is important to note that the design of the above-mentioned study was not appropriate for evaluating effectiveness, and numerous factors could have confounded its findings [32]. For example, patients experiencing positive outcomes early in their rehabilitation might have been more motivated to continue, while those experiencing poor outcomes initially might have dropped out, as they perceived the costs of supervised rehabilitation outweighed the benefits.

To determine whether supervised rehabilitation is superior to home-based programs we need to look to evidence from randomised controlled trials. These trials consistently demonstrate that supervised rehabilitation following ACLR is not superior to home-based rehabilitation [42–45]. For example, a physiotherapist-led exercise program (involving strengthening, neuromuscular training, aerobic exercise and a graded RTS; 20 sessions over 9 months) resulted in similar improvements in function, strength, hop test performance and sports participation compared to an identical home-based program guided by an exercise sheet (e.g. mean (range) Tegner Activity Scale at 12 months: intervention 6 (3–8) vs. control 5 (3–10),  $p > 0.05$ ) [43]. Similarly, 17 sessions of physiotherapist-led exercise were not superior to four sessions (when both had an identical home-exercise component that was similar to the above trial) for improving quality of life, range of motion, strength and knee laxity at any follow-up point up to 4 years (e.g. between-group

difference in LSI scores for peak quadriceps torque of 7%, 95% CI -4.6 to 18.7,  $p=0.23$ ) [44, 45].

Of course, if a patient desires more supervision and guidance it is their choice. But until evidence suggests otherwise, patients should be made aware that home exercise is not inferior to supervised rehabilitation, as this will facilitate shared decision making and could reduce over-treatment. There is no research comparing physiotherapist-led exercise to home-based programs for patients undergoing non-operative rehabilitation. However, since recommendations for post-operative and non-operative rehabilitation are largely similar, advocating physiotherapist-led exercise over home exercise for non-operative rehabilitation currently lacks support.

## 5 Conclusion

ACL injuries can have an enormous impact on a patient's quality of life and sports participation, and the messages injured patients receive are frequently misleading and create unrealistic expectations. Both surgeons and physiotherapists need to rethink the promises they are making and, instead, provide a more balanced, evidence-based view on the management options for ACL injuries. Patients must understand the risk of re-injury if they desire to RTS, particularly sports involving pivoting and cutting. For patients who understand the risks and opt for early ACLR, management should involve rehabilitation targeting strength and functional performance (with or without supervision), gradual progressions in training load, and an RTS of no earlier than 9 months to reduce the risk of re-injury. For other patients, conservative management as first-line treatment—with a similar but ultimately more accelerated approach to rehabilitation—is likely the best option. All patients should receive education on the relationship between injury risk and training load, and understand that a guided home-exercise program is not inferior to intensive physiotherapist-led exercise. This will help patients make an informed decision about the rehabilitation approach that best aligns with their preferences and RTS goals.

## Compliance with Ethical Standards

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