

ACL RECONSTRUCTION - IT'S ALL ABOUT TIMING

Stephanie Evans, PT, DPT¹Justin Shaginaw, MPT, ATC²Arthur Bartolozzi, MD²**ABSTRACT**

Injury to the anterior cruciate ligament (ACL) is the most common ligamentous injury, ranging from up to 200,000 injuries per year in the United States. Sports such as soccer, football, and skiing have been reported to be high-risk sports that can cause injury to the ACL when compared to other sport activities. Due to the high incidence of ACL injuries, approximately 100,000 ACL reconstructions are performed each year. Although conservative treatment can potentially be successful in the appropriate population, patients with goals of returning to high levels of sport activity may not be successful with conservative treatment. Even though reconstruction is the most common treatment for ACL rupture, there remains debate in the literature regarding the optimal timing of surgery. Therefore, the purpose of this clinical commentary is to review the available evidence to provide insight into the optimal timing of ACL reconstruction.

Keywords: Anterior cruciate ligament, arthrofibrosis, reconstruction, timing

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INTRODUCTION

Injury to the anterior cruciate ligament (ACL) is the most common ligamentous injury, ranging up to 200,000 injuries per year in the United States.¹ Sports such as soccer, football, and skiing have been reported to be high-risk sports and individuals who participate in these sports are 10 times more likely to rupture the ACL when compared to other sport activities.² Additionally, women who participate in intercollegiate soccer, basketball, and rugby are approximately four times more likely than males (who participate in those same sports) to rupture their ACL.³ The mechanism of injury to the ACL is associated with neuromuscular and biomechanical abnormalities, including large frontal and transverse plane movements of the knee, mutations within collagen producing genes, hormonal factors related to the female menstrual cycle, and primary anatomical and structural influences.⁴ For example, motions that occur with cutting and pivoting, such as varus/valgus and internal/external rotation movements at the knee, can result in rupture of the ACL.⁵

Due to the high incidence of ACL injuries, approximately 100,000 ACL reconstructions are performed each year.⁶ Although conservative treatment can potentially be successful in the appropriate population, patients with goals of returning to high levels of sport activity are typically not successful with conservative treatment.⁷ Even though reconstruction is the most common treatment for ACL rupture, there remains debate in the literature regarding the optimal timing of surgery.⁸ Smith et al⁹ concluded from their systematic review that there were no differences in clinical outcomes between early (less than 3 weeks) and delayed (greater than 6 weeks) ACL reconstruction (ACLR); however, their conclusion is based on present literature that has limitations, such as non-randomization and lack of appropriate blinding.⁹ From a patient perspective, high level athletes frequently request surgery as soon as possible in order to return to play whereas individuals who are not involved with physically demanding activities may delay surgery due to personal or societal obligations. In both instances, adverse complications, which will be discussed throughout this clinical commentary, can negatively affect patient outcomes. Healthcare providers, including physical therapists,

must be knowledgeable regarding the risks of early and delayed surgical intervention in order to educate patients appropriately; therefore, the purpose of this clinical commentary is to review the available evidence in order to provide insight into the optimal timing of ACLR.

REVIEW OF EXISTING EVIDENCE

Shelbourne and colleagues¹⁰ retrospectively studied 169 acute ACL reconstructions and evaluated the effect of timing of surgery and accelerated rehabilitation on patient outcomes. Patients who had undergone reconstruction within the first week of injury had a significant increase in arthrofibrosis compared to those who had surgery greater than 21 days from injury.¹⁰ Interestingly, patients who underwent reconstruction between 8 and 21 days from injury and underwent an accelerated rehabilitation program had a decreased incidence of arthrofibrosis as compared to those who underwent a conventional rehabilitation program. However, the results of this study are now greater than 20 years old and there have been multiple advancements in the acute management and surgical technique associated with ACLR, thus the results must be interpreted cautiously. Shelbourne and Patel¹¹ reviewed the perioperative factors that are important to consider prior to surgery. The authors concluded that mental preparation, scheduling, associated knee joint pathology and preoperative knee condition (i.e. minimal to no swelling, adequate strength, and full range of motion) should be carefully assessed to determine timing of reconstruction.

Furthermore, Almekinders and colleagues¹² studied 70 adults who underwent ACLR using a bone-patella tendon-bone autograft. Patients who underwent reconstruction less than one month from injury had limitations in knee range of motion early in rehabilitation; however, after one year, there were no differences in motion between patients who underwent early or delayed surgery. Passler et al¹³ assessed complications associated with timing of surgical intervention in 283 patients. Approximately 18% of individuals that had surgery within 7 days of injury developed arthrofibrosis, compared to only 6% of patients who waited at least 4 weeks.¹³ However, Bottoni and colleagues⁸ found no differences in knee

range of motion (ROM) between patients who underwent early reconstruction versus those who waited at least 6 weeks. But, the patients who participated in the study were active military personnel and may not be representative of the general population, thus generalization is limited.

Mayr et al¹⁴ studied the effect of timing as well as preoperative knee status on ACLR outcomes. The authors documented the irritability of the knee before surgery (i.e. swelling, effusion, hyperthermia), ROM, and additional injuries. The authors reported a correlation between reconstruction within the first 4 weeks of injury and the development of arthrofibrosis. However, the authors also found a strong association between preoperative irritation of the knee and arthrofibrosis. Interestingly, those who underwent surgery after 4 weeks with an irritated knee had a similar chance of developing arthrofibrosis as those who underwent an earlier reconstruction. Preoperative deficits in knee extension and knee flexion ROM were also predictive of postoperative arthrofibrosis. The results of this study indicate that the status of the knee prior to surgery may be a more important factor than injury-to-surgery interval in determining optimal timing of reconstruction.¹⁴

Conversely, delayed ACLR is another topic of interest when investigating optimal timing of ACLR. Operational definitions for delayed versus early ACLR may

vary between authors, thus careful analysis and interpretation of results is critical. For example, Frobell et al¹⁵ defined early reconstruction as being performed within 10 weeks after injury. The authors did not specifically define delayed reconstruction; however, in their study, delayed reconstruction was performed between 5.5 and 19 months following randomization. Alternatively, Meighan et al¹⁶ defined early as surgery occurring within 2 weeks and delayed as occurring within 8-12 weeks (Table 1).

Patients with ACL-deficient knee often have chronic rotational and translation instability that can cause giving way episodes as well as further knee damage including meniscal tears, osteochondral defects, and ligament tears.¹⁷ Church and Keating¹⁸ reviewed 183 patients who had undergone ACLR to analyze the incidence of meniscal tears and degenerative change in relation to the timing of surgery after injury.¹⁸ Their results showed that there was a significant increase in meniscal tears in those individuals who had undergone surgery greater than 1 year after injury. Using the French Society of Arthroscopy (SFA) system, a higher incidence of knee degeneration was found in those who waited more than 12 months to have surgery.¹⁸

Kennedy et al¹⁹ found similar results regarding the relationship between timing of ACLR and prevalence of meniscal and chondral defects. Athletes

Table 1. Operational definitions of early versus delayed ACL		
Study	“Early” ACLR Definition	“Delayed” ACLR Definition
Frobell et al ¹⁵	Within 10 weeks after injury	Offered no specific definition; however, delayed was performed between 5.5 and 19 months after randomization
Meighan et al ¹⁶	Within 2 weeks	Within 8-12 weeks
Church and Keating ¹⁸	Within 12 months	After 12 months
Kennedy et al ¹⁹	Offered no specific definition	Offered no specific definition; divided patients into groups A (0-2 months), B (2-6 months), C (6-12 months), D (12-18 months), E (greater than 19 months)
Bottoni et al ⁸	Early possible date from injury	A minimum of 6 weeks from injury
Smith et al ⁹	Within a mean of 3 weeks post-injury	A minimum of 6 weeks from date of injury

who had undergone reconstruction at least one year after their initial injury had a significantly higher incidence of medial meniscus tears. However, there was no association between lateral meniscus pathology and timing of surgery. The authors also found a higher occurrence of degenerative changes in those who had surgery six months after injury. Åhlén and colleagues²⁰ found that patients who underwent reconstruction within 5 months of injury had better outcomes on the Lysholm Knee Questionnaire and Tegner Activity scale as compared to patients who waited at least 24 months to have surgery. There was no statistically significant difference in the incidence of meniscal tears between groups; however, the authors state that this may be due to a Type 2 error that occurred due to low sample size.

Granan et al²¹ organized a large cohort study which prospectively collected information regarding all cases of ACLR in Norway. The authors analyzed 3699 patients who underwent primary ACLR in order to determine the association between timing of surgical intervention and the risk of developing additional pathology.²¹ The authors did not find an association between the development of articular cartilage or meniscal pathology in children (16 years or younger). However, in young adults (17-40 years) and older adults (41 years and older), for each month that passed from initial injury to surgery, the odds ratio for an articular cartilage lesion increased by approximately 1%. Anstey and colleagues²² found the prevalence of new medial meniscus tears in individuals who underwent surgery less than 6 months and more than 6 months to be 4.1% and 16.7%, respectively.

DISCUSSION

The optimal timing of ACLR is an important clinical decision that affects patient outcomes significantly. Even though there is no consensus in the literature, there are some trends regarding timing of ACLR. Various authors suggest that ACLR be performed at least 3 weeks after injury in order to avoid arthrofibrosis.^{10,11,12,13} More important than time alone, objective criteria including perioperative swelling, edema, hyperthermia, and ROM are important indicators of when surgery should be performed.¹⁴ Preoperative quadriceps strength has also been suggested to

influence outcomes following ACLR. Eitzen et al²³ found that patients with quadriceps strength deficits greater than 20% prior to surgery had significantly greater deficits in strength two years following surgical intervention. Thus, these authors suggest that surgery be performed only when involved quadriceps muscle strength is 80% of the uninvolved lower extremity.

Timing of surgical intervention may only be one factor that should be considered when determining optimal timing of surgery. The decision of when to undergo ACLR is likely multifactorial and may include factors such as pre-operative status of the knee, family, school or work obligations, as well as mental preparation. More research is needed in order to identify a multifactorial objective algorithm that could be used to assist the surgeon and patient in determining when surgical interventions should occur in order to yield optimal clinical results.

Throughout the literature, there appears to be a lack of consensus regarding the operational definitions of early versus delayed ACLR (Table 1). Of the studies included in this clinical commentary, no two studies used the same definition of early versus delayed. Church and Keating¹⁸ used 12 months as a marker to distinguish between early versus delayed. Bottoni et al⁸ defined early reconstruction as occurring at the earliest possible date from injury and delayed reconstruction as a minimum of 6 weeks from the date of injury. Due to the considerable variation in injury-to-surgery interval, it appears that a third definition of acute ACLR may be helpful in order to clearly delineate timeframes. More precise operational definitions of acute, early, and delayed may allow for better control and generalization of results across the literature.

Post-operative rehabilitation has changed substantially as improved surgical techniques have evolved. In a recent clinical commentary, the authors advocated for an objective based rehabilitation program that focuses on meeting specific clinical milestones prior to progressing to the next stage of rehabilitation.²⁴ Current surgical techniques allow for accelerated rehabilitation with emphasis on early mobilization, weight bearing, and lower extremity strength training following isolated ACLR.²⁵ With advanced surgi-

cal techniques and accelerated rehabilitation, further research is needed to determine the effects of acute inflammation of the knee on the reconstructed ACL and other intra-articular structures, which may affect long-term post-operative outcomes. The option of surgical intervention within days of injury may appeal to professional athletes or other individuals who must return to their prior level of functional as soon as possible. Conversely, the option of delayed surgical intervention may appeal to others who have less rigid time constraints or may desire to prepare to a greater degree pre-operatively.

CONCLUSIONS

There are significant potential complications associated with both early and delayed surgical reconstruction of the ACL, which can negatively affect clinical outcomes. The careful consideration of these complications is paramount when healthcare professionals, including both the physical therapist and surgeon, educate patients on the optimal timing of ACLR. As such, physical therapists should be diligent in regularly reviewing the literature in order to ensure that as new evidence emerges, accurate and effective education can be given to all patients considering ACLR.

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