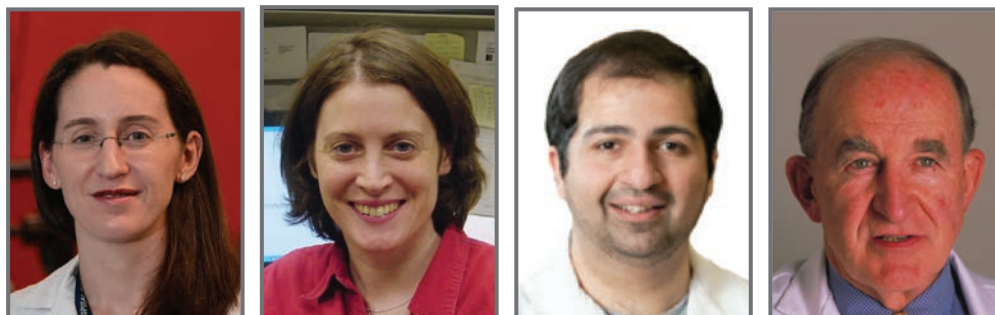


How can practitioners decide when to reconstruct a torn anterior cruciate ligament?



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“Patients have a variable ability to function with anterior cruciate ligament deficiency based on anatomic differences, activity level and expectations.”

Anterior cruciate ligament (ACL) injuries are a common problem with 80,000 ACL injuries in the athletic population and 200,000 in the general population annually in the USA [1,2]. With growth in youth sports and activities, ACL injuries are a problem in the active adolescent population [3]. ACL reconstruction techniques designed to restore knee stability and protect the menisci and cartilage from damage are popular, but the decision of in whom to perform a reconstruction is not as clear as simply identifying a torn ACL on MRI. Some patients can develop functional stability with conservative treatment, while others require operative reconstruction to provide stability. Age, activity level, patient expectations, knee stability, mechanical alignment and cartilage status each play an important role in deciding who will maximally benefit from a surgical intervention versus nonoperative rehabilitation and/or bracing. In addition, one must consider the risk of joint degeneration and osteoarthritis (OA) to the knee with and without a functional

ACL. The kinematics and contact mechanics of the knee with and without an ACL or an ACL reconstruction have been studied to provide greater insights into the role of the ACL in joint contact stresses and potentially OA [4].

Patients have a variable ability to function with ACL deficiency based on anatomic differences, activity level and expectations. Noyes *et al.* proposed a ‘rule of thirds’ in the 1980s [5]. ‘Copers’ are the one third of patients that resume activities and manage well without reconstruction, ‘adapters’ manage by modifying activities and ‘noncopers’ have recurrent instability with activities and require ACL reconstruction to restore functional stability. Very few studies have successfully addressed how to identify the potential copers from the noncopers and thereby focus ACL reconstructive surgery on those patients who will derive maximal benefit. Copers have been shown to have movement patterns consistent with knee stability [6] with significantly less anterior laxity, fewer incidences of instability or episodes

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of ‘giving way’, significantly higher activity level and greater outcome scores at 1 year of conservative treatment compared with noncopers [7]. One of the central concepts of knee stability in the setting of ACL deficiency lies with the quadriceps mechanism. Noncopers and copers have different activations or deactivations of the quadriceps mechanism and thus have different movement patterns and stability. A recent study looked at copers and noncopers 4 months postinjury, and the noncopers had poor gait performance for kinematics and time–distance variables versus copers [8].

Can noncopers be trained with rehabilitation to become copers? While most noncopers are referred for surgery, particular types of rehabilitation programs are available that help to develop a sense of functional stability and thereby defer a surgical procedure. Augmenting nonoperative ACL rehabilitation programs with perturbation training programs may improve proprioception and increase the chance of converting to a copers [9] with better dynamic muscular control and knee kinematics [10].

Buss *et al.* reported on conservatively treated patients who either had an age greater than 30 years, a sedentary lifestyle and occupation, or a low athletic activity level [11]. Of that cohort, 85% felt their symptoms after conservative management were not severe enough to warrant an intervention and only 15% underwent surgery. Buss concluded that in a particular group of older patients who are relatively inactive and willing to accept a risk of future instability and meniscal injury, conservative management can be successful [11]. Hetsroni *et al.* reported on middle-aged (average age: 43 years) alpine recreational skiers treated with non-operative management [12]. These middle-aged patients who injure the knee while skiing present an interesting pattern of ACL proximal avulsion but with good orientation of the ACL tissue. These patients, if treated nonoperatively may heal with a good restoration of the end point on a Lachman test and a negative pivot shift. If surgery is performed early at 3–4 weeks the surgeon would note that the ACL is incompetent. However, if 6–8 weeks pass before arthroscopy, the ACL has a better opportunity to scar in and function. These patients, while at greater risk for re-injury of the ACL and meniscus, will do well over 80% of the time.

A few studies have evaluated the outcomes of conservatively treated patients with ACL deficiency. A Swedish study group followed 200 patients with ACL deficiency over a 15-year period of being treated conservatively. Good subjective results and a satisfactory activity level were achieved with conservative management and only 23% of patients required an ACL reconstruction for stability and return to sport [13]. Neuromuscular rehabilitation, early activity modification and a gradual return to sport allowed good function with 60% of patients returning to preinjury activity level within 3 years and 12% decreasing their activity by one level [13]. These authors concluded that because good results can be achieved in the majority of patients without ACL reconstructive surgery, a more prolonged course of nonoperative management may be advisable to determine which patients can become copers. However, a Norwegian study group looked at patients who tore their ACL during high-risk activities and found that the initial evaluation to determine which patients may be able to restore dynamic stability without the ACL could not accurately predict the true copers [14].

The Delaware study group evaluated patients prospectively over a 10-year period with subacute ACL injuries. Copers were classified as those who had:

- A hop test index of 80% or greater for the timed 6-meter hop test;
- Knee outcome survey activities of daily living scale score of 80% or more;
- Global rating of knee function of 60 or more;
- No more than one episode of instability or giving-way postinjury [15].

Of the entire study cohort, 42% were initially classified as copers; however, 89% of the cohort ended up with a surgical ACL reconstruction [15]. Their treatment algorithm was useful for those potential copers who desired nonoperative management. In the group of patients who were classified as copers and who desired nonoperative management, 72% were able to return to preinjury sport level, but overall 57% ultimately required reconstructive surgery [15]. The results of this study are useful as a guide to determine which patients may be candidates for nonoperative management. However, a large

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percentage of patients ultimately required a surgical reconstruction to achieve their desired level of function and knee stability with athletic activity.

The current theory on ACL reconstruction in the USA would dictate that young, active athletes who desire a predictable return to sport in the setting of an otherwise healthy knee should undergo ACL reconstruction. The ACL is known to provide anterior and rotational stability to the knee and, in effect, protect the menisci, which can serve as a secondary restraint for anterior stability. The menisci, in turn, provide increased surface area for the joint in order to decrease the peak load and contact forces on the cartilage surfaces. In essence, the ACL protects the menisci which protect the cartilage. The essential goal of a healthy knee is stability and preservation of the chondral joint surfaces. When the ACL is torn, the other structures are potentially at risk and the ACL reconstruction provides a relatively predictable return of stability. Despite the clear protective effect of ACL reconstruction against meniscal injury, long-term studies on ACL reconstructions are unclear as to the effect of restoration of stability on development of arthritis. ACL injury in itself may predispose the knee to development of arthritis [16]. Overall surgical outcomes are good with some studies reporting as many as 70% of individuals returning to sport at 2 years, with the percentage declining over time [17].

As the number of ACL injuries continues to increase in the general population, especially the pediatric and adolescent age groups, we still have unanswered questions as to who exactly requires an ACL reconstruction and who can be treated conservatively. The above guidelines are a good beginning yet none are entirely accurate in identifying the best candidates for surgical or nonoperative treatment. Future research into new predictive models to both restore knee stability and to help avoid development of post-traumatic OA is critical to answer these questions.

In a recent study, Bedi *et al.* used cadaveric knees to examine how knee shape impacts knee mechanics during gait both before and after a person has torn their ACL [4]. Kinematic and contact mechanics were highly variable across the knees after ACL transection, but there was a statistically significant increase in contact stress in the posterocentral aspect of the medial

tibial plateau at the point of the gait cycle that correlates with mid-late stance. The osseous geometry of the knees, particularly decreased tibial medial concavity, increased tibial slopes and smaller changes in the location of the center of rotation were predictive of higher stresses in the antero-central region of the tibial plateau [4]. This cadaveric study gives significant insight into what happens to knee stability and contact pressures with and without an ACL and why meniscal and chondral damage occur in the setting of ACL deficiency. In addition to beginning to explain why OA occurs in certain regions of the post-traumatic ACL knee, it may also provide a framework to determine which patients require ACL reconstruction based on the osseous geometry.

The development of post-traumatic OA after ACL injury is well documented [18,19]. However, the time course to symptomatic OA is longer than the time course for determining whether or not to reconstruct a torn ACL. An additional key step in the decision-making process may be the cartilage status over time of the ACL deficient knee. Moksnes *et al.* prospectively evaluated skeletally immature patients with ACL tears treated conservatively with MRI over an average of 3.8 ± 1.4 years [20]. The incidence of new injuries to menisci and cartilage between the initial and follow-up MRIs was low, but overall 19.5% required meniscal procedures and 32% required ACL reconstruction [20].

ACL injuries are an increasingly common problem with both conservative and surgical treatment options. The decision of in whom to perform a reconstruction is difficult, but new work on rehabilitation protocols, knee geometry, contact mechanics and kinematics will ultimately provide more information to decide up front who requires an ACL reconstruction for knee stability and a return to activities.

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