Identifying Individuals With an Anterior Cruciate Ligament-Deficient Knee as Copers and Noncopers: A Narrative Literature Review

Despite the thousands of published articles on anterior cruciate ligament (ACL) injury, how to determine which individuals may or may not be candidates for surgical intervention remains to be established. Two treatment options, nonoperative management or reconstructive surgery, are available for an individual with ACL deficiency (ACLD). Controversy exists as to which intervention results in a more successful functional outcome for individuals with ACLD.

Previous studies have reported poor individual outcomes after nonoperative management of ACL injury, further reinforcing a preference for surgical management. Nearly 25 years ago, the well-known “rule of thirds” was proposed for ACL injuries treated with rehabilitation. It stated that one third of individuals can resume previous recreational activities without reconstruction (“copers”), one third can manage without reconstruction by modifying/lowing their activity level (“adapters”), and one third require reconstruction because of recurrent giving-way episodes in activities of daily living (“noncopers”).

Very few randomized or quasi-randomized clinical trials address the basic question as to whether an ACL rupture necessarily requires surgical reconstruction. Despite this, the vast majority of orthopaedic surgeons in the United States, where more than 200,000 ACL reconstructions are performed annually at a cost of $3 billion, advocate early surgical intervention when managing patients with ACL rupture who wish to resume high-level sports activities. The figures in Europe are probably somewhat less, with no overall data reported. In Sweden for example, 3000 ACL reconstructions are performed annually.

This standard of practice of performing ACL reconstruction is influenced by both a high return-to-sport rate after surgery and the assumption that resuming jumping, cutting, and pivoting sports...
without ACL reconstruction will inevitably result in knee instability. There is also easy access to surgical facilities and widespread private health insurance coverage of the procedures. Nevertheless, there is no evidence to date that clearly establishes that noncopers, as determined soon after an ACL injury, should be excluded as rehabilitation candidates.

There is no consensus, based on objective criteria, on when, if at all, an individual should return to high-level sports after ACL reconstruction or nonoperative treatment. The benefit of early ACL reconstruction to regain the desired activity level and contribute to subjective well-being is, therefore, not obvious. Continued high athletic demands after an ACL rupture have been reported to eventually lead to meniscal damage, articular cartilage damage, and degenerative arthritis, although this has not been clearly demonstrated. It seems, from the literature, that the primary indication for individuals with an ACL injury to have had ACL reconstruction is to restore knee stability and enable return to the desired activity level. However, few studies have shown that ACL reconstruction actually restores dynamic knee stability (more simply understood as not giving-way) or enables full return to preinjury activity level in most individuals.

The primary objectives of this narrative literature review are as follows: to explore the differences and the outcomes between individuals who have ACL reconstruction and those who have not undergone surgical intervention; to review the evidence related to the ability to identify individuals who may or may not need surgery after an ACL rupture; and to describe the differences between copers and noncopers.

**METHODS**

The author undertook a computerized bibliographic database search within the medical and allied health literature. The following databases were searched from their inception to April 2011: Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBase, CINAHL, and the Musculoskeletal Injuries Group’s specialized register. The subject-specific search was based on the terms “anterior cruciate ligament surgery versus conservative treatment,” “copers,” and “noncopers.” The search was restricted to studies that included human participants and were published in English. The reference list of relevant articles was also reviewed to identify additional publications not identified in the formal search strategy.

**RESULTS**

The results of the literature search are summarized in Figure 1. The literature search identified 84 articles, and 16 additional articles were identified through other sources, such as communication with content experts in the field of ACL screening and rehabilitation and the 2010 conference proceedings of the American College of Sports Medicine and European Society of Sports Traumatology, Knee Surgery, and Arthroscopy. Removal of duplicates left a total of 96 potential articles, from which 12 articles were excluded for not meeting the inclusion criteria, as set forth in the Methods section, and a further 19 articles were excluded for their poor research quality. The balance of 65 full-text articles were thus reviewed, of which 5 were randomized controlled trials (RCTs) dealing specifically with the topic of operated versus nonoperated individuals and copers versus noncopers.

**Definitions: Copers, Noncopers, and Adapters**

ACL injury potentially has deleterious effects on knee muscle function, knee kinematics, knee stability, and proprioception. While the majority of individuals with an ACL-deficient knee lack dynamic knee stability, some seem to have the ability to dynamically stabilize their knee, even during pivoting sports activities. These individuals may be de-
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Defined as copers, in that they are able to resume all preinjury activities, including sports, without episodes of knee giving-way, and do not require surgery.16,64 Numerous researchers have included their own variations to this basic definition. The Delaware group stipulated that this ability to participate must continue for at least 1 year after ACL injury,31 while a Swedish group further specified that the copers must be able to return to function at a high level (level 1 sports: jumping, cutting, pivoting)34,35 at least weekly after injury, without complaint of instability.24,27,40 Noncopers, on the other hand, have been defined as individuals who either did not return to their previous activity level or experienced giving-way episodes on resumption of preinjury activities.16,49,57,58,64 A third category of those described as “adapters” consists of individuals who have been defined as demonstrating more than 3 mm of side-to-side difference in ACL laxity at initial examination.32 This definition is, however, problematic, as laxity measurements have been reported to have little predictive value in differentiating between copers and noncopers.16,56,64 These so-called adapters represent the vast majority of individuals with ACLD who are managed nonoperatively and are able to avoid evoking episodes of instability by modifying their activity levels.

Differences Between Copers and Noncopers

Researchers have investigated whether differences exist between copers and noncopers and whether clinicians can identify those patients who may be able to cope with ACLD.31 Evidence suggests that potential copers, identified by a screening examination, have movement patterns consistent with those of individuals who have good functional knee stability (ie, not giving way), as opposed to noncopers.31 It has been reported that true copers had significantly less anterior tibiofemoral knee joint laxity, fewer giving-way episodes, significantly higher activity level, and greater improvement in Knee Outcome Survey activities of daily living scale and International Knee Documentation Committee scores compared to true noncopers at a 1-year follow-up.49 No statistically significant differences between true copers and true noncopers were observed for any of the single-leg hop tests. A small sample of noncopers who performed hop tests displayed reduced knee range of motion and external knee flexion moments as opposed to copers.29 Noncopers walked with significantly reduced knee compression and shear forces versus controls.1 Copers performed better (P < .05) than noncopers on all 4 hop tests.10 Diminished quadriceps control was observed when people with ACLD performed static and dynamic tasks.25 The most striking feature of this impaired control was failure to turn the quadriceps off when performing flexion tasks in which the knee extensors are usually silent. The findings suggest that poor control of quadriceps activation after ACL injury is relatively consistent. Noncopers exhibit a stiffening strategy, consisting of lower sagittal plane knee motion and knee moments and higher muscle cocontraction, in comparison with their contralateral limb and individuals without injuries, to maintain knee stability in the absence of ligamentous support. Conversely, potential copers have movement patterns somewhere between those of individuals without injuries and those of noncopers.26 In a recent publication,9 it was reported that, at 4 months postinjury, noncopers had poorer gait performance compared to copers for kinematics and time-distance variables. Noncopers seem to utilize a common abnormal movement pattern of lower knee extensor loading even during unanticipated tasks.31 Functional outcomes further suggest that a subgroup of noncopers require additional supervised rehabilitation to pass stringent criteria to return to sports.24 Studies have revealed significant differences in angle-specific knee torque values between potential copers and noncopers (P < .05).67 Moderate to strong associations were noted between angle-specific torque values and single-leg hop performance, but only for noncopers (r = 0.32–0.58). It was concluded that angle-specific quadriceps muscle torque values measured at less than 40° of knee flexion provide more information on the quadriceps strength deficits after ACL injury than the commonly used peak torque values. Two studies have analyzed electromyographic patterns of individuals with ACLD during an unanticipated cutting task during walking. Individuals in the coper group preferentially used a particular vastus lateralis and medial hamstrings activation pattern at a frequency more than twice that observed in the control group.23,24 The noncoper group, compared to the control group, also preferentially used a medial hamstrings activation pattern more than twice as often and utilized a distinct medial hamstrings and lateral hamstrings activation pattern.

Can Noncopers Become Copers?

Currently, most noncopers are referred for surgery35,49 without testing whether it might be possible for them to become true copers and to avoid a surgical procedure and the ensuing lengthy rehabilitation process. The first published RCT on the topic indicated that noncopers who received perturbation training combined with a standard nonoperative ACL rehabilitation program had a greater increase in Lysholm Knee Rating Scale scores after training than subjects who received only the standard program.7 A more recent RCT trial studied 26 individuals with acute ACL injury or rupture of an ACL graft, who were randomly assigned to either a standard rehabilitation program (standard group) or the standard program augmented with a perturbation training program (perturbation group).22 Results of this study led to the conclusion that augmenting nonoperative ACL rehabilitation programs with perturbation training techniques may enhance the probability of a successful return to high-level physical activity by reducing the risk of continued episodes of giving-way of...
the knee during athletic participation. This allows individuals to maintain their functional status for longer periods. More recently, following a preoperative perturbation training program, it was shown that noncopers who received perturbation training and progressive quadriceps strength training had more symmetrical strength and knee movements 6 months postoperatively compared to noncopers who received strength training alone. A similar study was conducted using perturbation training on potential copers. It was found that perturbation training reduced quadriceps femoris hamstring cocontractions and normalized knee kinematics.

**Surgery Versus Conservative Treatment**
In 2005, a Cochrane review published by a Finnish group concluded that there was insufficient evidence from randomized trials to determine whether surgery or conservative management was best for ACL injury in the 1980s and that there was no existing high-level evidence to advise current practice management. A more recent systematic review explored the prognosis of conservatively managed ACL injury. The authors concluded that, on average, individuals with an isolated ACL tear or an ACL tear with an associated injury (eg, torn meniscus) reported good knee function (87/100 on the Lysholm Knee Scale) at a 12- to 66-month follow-up. On average, functional performance assessed with the hop-for-distance test was in the normal range. From preinjury to follow-up, there was a reduction in Tegner activity level of 21.3%. According to the methods used in the assessed studies, individuals with a conservatively managed ACL tear have a good short- to medium-term prognosis in terms of self-reported knee function and functional performance. However, individuals reduced their activity levels by 21%, on average, following injury. A closer look at the literature involving the sports population reveals an interesting picture. In 1 study, at a 6- to 11-year follow-up, 18 of 22 (82%) competitive handball players treated without reconstruction returned to their preinjury activity level, compared to 33 of 57 (58%) in those who had ACL reconstruction. The conclusion of this paper was not that conservative management is better but that the return to preinjury level of play following an ACL injury is limited, irrespective of management. This study predominantly included women as compared to men (50 to 29), which is not typical of most studies. In a group of 38 former college or high school athletes with chronic ACL injury, a low rate of functional limitations was reported. In a review of follow-up studies on the treatment of ACL injuries, the rate of return to preinjury activity level ranged from 8% to 82% in patients who had undergone reconstruction, and from 19% to 82% in patients who did not have reconstruction.

**Randomized Controlled Trials**
Although many reviews related to ACLD, copers, and noncopers were retrieved, only 3 RCTs compared surgical and non-surgical treatment. The first 2 RCTs assessed surgical reconstruction of the torn ACL and the most recently published RCT compared 2 strategies for managing an ACL tear in a population of non-elite athletes. The authors of the latter concluded that in young, active adults with acute ACL tears rehabilitation plus early ACL reconstruction was not superior to rehabilitation plus optional delayed ACL reconstruction. The latter strategy substantially reduced the frequency of surgical reconstructions. Two observational studies have shown similar outcomes for patients who underwent ACL reconstruction.

**Algorithms and Screening Examination**
As some individuals have the potential to manage well without an ACL reconstruction following an ACL injury, the challenge in the management of patients with...
ACL injury is to develop an algorithm or screening examination that effectively, soon after injury, identifies copers and noncopers. The intention would be to create a tool that could potentially identify those individuals who, early after an ACL tear, may have the potential to return to preinjury activity level for a limited time.

Three published papers have reported on the use of an algorithm and screening examination with that goal in mind, and are specifically discussed below.

**The Swedish Group Study**
A team of Swedish investigators followed 200 individuals with ACL injuries over a 15-year period and reported on the individuals who had unilateral nonreconstructed ACL tears. Their main hypothesis was that good knee function and a satisfactory activity level could be achieved by early activity modification and neuromuscular rehabilitation, thereby limiting the need for reconstruction surgery.

Their primary findings were that good subjective results and a satisfactory activ-
ity level can be achieved in the majority of patients, limiting the need for ACL reconstruction in these patients to only 23%. Early activity modification, neuromuscular rehabilitation, and a gradual return to activities resulted in good knee function and an acceptable activity level. Approximately 60% of the patients resumed their preinjury activity level within 3 years of injury and an additional 12% decreased their activities by just 1 level. The results achieved with the Swedish group’s specific treatment algorithm are similar to those presented in studies of surgically treated individuals, both at medium- and long-term follow-up. The authors concluded that because a high proportion of patients can cope without reconstructive surgery, it is better to adopt a restrictive attitude towards early surgical reconstruction.

The Delaware Group Study

A team of investigators from Delaware published a 10-year prospective study involving the largest group (832) of highly active individuals with subacute ACL tears. Their main objective was to utilize a treatment algorithm and screening examination to guide individual management and determine potential for highly active individuals to succeed with nonoperative care. Concomitant injury, unresolved impairments, and a screening examination were used as criteria to guide management and to classify individuals as noncopers or potential copers for nonoperative care (FIGURE 3). The individuals who met all inclusion criteria completed the screening examination a mean of 6 weeks after injury. Potential copers were classified as individuals who met all of the following criteria at the screening examination: (1) hop test index of 80% or more for the timed 6-meter hop test, (2) Knee Outcome Survey activities of daily living scale score of 80% or greater, (3) global rating of knee function of 60 or greater, and (4) no more than 1 episode of giving-way since the injury. Potential noncopers were classified as those who did not fulfill the above criteria.

There were 199 (58%) individuals who were classified as noncopers and 146 (42%) as potential copers. On completion of the study, only 25 (39%) of those who returned to sports did not undergo surgical reconstruction. The final figures show that 89% (308/345) of the initial group were known to have gone on to surgery, whereas, only 7% (25/345) did not. The other 4% were lost to follow-up. They concluded that their classification algorithm was an effective tool for prospectively identifying those individuals who, early after ACL injury, wanted to pursue nonoperative care or had to delay surgical intervention and had good potential to do so. Seventy-two percent of the potential copers who elected nonoperative management were able to successfully return to preinjury sports activities without further episodes of instability or a reduction in functional status. Thirty-six (57%) of these potential copers ultimately had reconstruction surgery.

Despite this, the authors strongly encouraged all patients identified as potential copers who elected nonoperative management to do so only after participating in rehabilitation that includes perturbation activities. These may be understood as activities that challenge balance, such as standing on an unstable surface or responding to externally applied forces. Their stated intention, with development of the screening examination, was to identify individuals who might be successful with short-term (ie, 6 months or less) nonoperative management.

The Norwegian Group Study

The third and final group carried out a 2-year prospective cohort study consisting of 125 patients with ACL injuries who were participating in level 1 (jumping, cutting, pivoting) and 2 (heavy...
physical work, skiing, or tennis) sports at the time of injury.26

Their screening examination consisted of (1) the timed 6-meter hop test,21 (2) the Knee Outcome Survey activities of daily living scale,26 (3) the global rating of knee function assessed by a visual analogue scale,21 and (4) determining the number of episodes of giving-way since the injury.21 Screening was performed within 6 months of injury. On analysis, the positive predictive value of classification as a potential coper at the screening examination was 60% (95% CI: 41%, 78%), while the negative predictive value of the classification was 30% (95% CI: 16%, 49%). This showed that, for all elements of the prognostic accuracy profile, the results were not statistically significant, as the 95% CIs included the null values for the statistics. The null values for sensitivity, specificity, and positive and negative predictive values were all 50%, indicating that the level of prognostic accuracy was no different than random occurrence. Therefore, the screening examination had a poor predictive value for correctly classifying copers and noncopers at the 1-year follow-up, bringing into question the use of this screening examination and criteria to determine who should have surgery after ACL injury.

Their investigation provides preliminary support for the possibility that a significant proportion of individuals who are initially considered as potential noncopers may be able to regain dynamic knee stability similar to potential copers. One year after the screening examination, 60% of those originally classified as potential copers were true copers, while 70% of the individuals initially classified as potential noncopers were also true copers. Individuals who underwent ACL reconstruction, as well as those who followed a conservative rehabilitation program, showed excellent results on functional questionnaires at the 1-year follow-up exam. Thus the Norwegian group’s study has provided a scientific rationale for not excluding potential noncopers from nonoperative treatment soon after the injury.

The most recent of the papers28 concerning the value of the screening examination investigated whether functional tests incorporated in the original screening examination could contribute to explaining those who later go through ACL reconstruction. It also examined whether changes in the content or the time of conducting the screening examination (before or after 10 sessions of exercise therapy), could improve its explanatory value. The authors concluded that conducting the screening examination after 10 sessions of progressive exercise therapy gave the overall highest explanatory values, suggesting that the screening examination should be conducted subsequent to a short period of rehabilitation to inform decision making for ACL reconstruction.

DISCUSSION

Controversy still exists over whether good functional performance can be achieved in the short and long term in individuals with ACLD who choose a conservative (nonsurgical) management approach following injury. The primary issue is whether these individuals can return to preinjury level of play.

There is reasonable evidence to recommend that all individuals who sustain ACL injury undergo preoperative intervention, which includes the timely application of the algorithm for an evidence-based determination of the indication for surgical reconstruction. The results presented above indicate that a large percentage of individuals identified as rehabilitation candidates, using the treatment algorithm and screening examination, who elect nonoperative care were able to delay surgery without experiencing further knee instability. Rehabilitation of the injured knee takes time, and there is a concern that excluding potential copers from nonoperative treatment may lead to unnecessary surgery in a number of individuals and exclude potential noncopers from significant preoperative rehabilitation.

The different knee joint loading patterns observed between noncopers and copers reflect the different walking strategies adopted by these groups, which may have implications for knee joint stability. The strategy adopted by the copers may reflect an effective way to stabilize the knee joint during walking after an ACL rupture and the key role that knee kinematics might play in this strategy. It is clinically relevant to investigate if gait retraining would enable noncopers to walk in a manner similar to copers and thereby improve their knee joint stability.

We still do not have the optimal set of criteria to correctly assign individuals with an ACL tear to the correct treatment early after injury. No single outcome measure is sufficient to determine the functional status of individuals with ACLD. Consequently, the KOS-Sport, Global Knee Function Rating, hop tests, and Quadriceps Index should all be included when assessing these patients.31 Although perturbation training positively influenced the negative effects following ACL injury, it remains uncertain how long these changes may last and what the long-term outcomes are.

A few comments are warranted on outcomes for young active adults with an acute ACL tear who underwent rehabilitation followed by early ACL reconstruction. Outcomes in this group were not superior to those who underwent rehabilitation followed by optional delayed ACL reconstruction. In fact, in that study, the latter strategy substantially reduced the frequency of surgical reconstructions. However, long-term observational studies of early versus delayed ACL reconstruction have shown that delayed surgery may be associated with a significantly greater rate of damage to the meniscus, the articular cartilage, or both.3,5,5,18,19,24,46

Given the growing evidence that early-onset knee osteoarthritis is a risk after ACL rupture, whether the injury is managed operatively or nonoperatively,38,45,65

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we must question if surgical intervention in an individual without symptoms has become more a matter of usual practice rather than evidence based. It seems that the resumption of the previous activity level following ACL tear may increase the risk of future osteoarthritis, regardless of whether the ACL is reconstructed or not.\(^{19,32,45,57}\) Individuals with the highest preinjury activity level seem to have a higher probability of not returning to their preinjury activity level. This may possibly be due the fact that as many as 20% of them have fear of reinjury.\(^{41}\)

It may be beneficial to compare or weigh the benefits of operative versus nonoperative management in this quest to identify copers and noncopers. Not specifically reviewed in this manuscript are the potential complications related to operative management, such as time, costs, quality of life, and complications such as arthrofibrosis, graft failure/rejection, and revisions. These are very important considerations when considering surgery versus the potential consequences of nonsurgical management. Studies with larger outcomes are necessary to confirm the consequences of long-term nonoperative management.

**CONCLUSION**

For individuals who injure their ACL, choosing between surgical or nonsurgical conservative management can be a complex decision. It depends on lower extremity function/dynamic stability, the type and level of sport activities, and the individual’s own interest in modifying his/her activity level. For those who choose to return to pivoting sports, especially at a high level, surgery still seems to be the preferred treatment. Despite this generally accepted approach, there are some individuals who may do well without surgery, even at a high level of function and sports participation. The goal of determining who can do well without surgical reconstruction has had sparse attention in the literature and remains the ultimate challenge of future research.\(^*\)

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