Current Recommendations for Anterior Cruciate Ligament Bracing: When to Use

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Brendan D. Masini, MD[1]
Brett D. Owens, MD[1]

[1]John A. Feagin Jr. Sports Medicine Fellowship, Keller Army Community Hospital, West Point, NY

Abstract: Braces are often used during various stages of recovery from an anterior cruciate ligament tear despite there being sparse definitive research supporting their use. This article reviews the literature on brace use for patients with anterior cruciate ligament tears in order to provide a guide for clinicians. There is evidence to support immediate postoperative bracing, with the goals of maintaining full extension and decreasing effusion. There may be a psychological benefit for its use in return to sport; however, this should be weighed against decreased performance. In the context of modern graft-fixation techniques and early mobilization protocols, empiric functional brace prescription is not required for successful long-term clinical outcomes and return to sport.

Keywords: anterior cruciate ligament; prophylactic bracing; postoperative bracing; functional bracing

Introduction

Over the past 10 years, the orthopedic community has begun to recognize that the peer-reviewed literature does not support empiric postoperative functional bracing after anterior cruciate ligament (ACL) reconstruction surgery. In addition, mounting pressure to reduce costs associated with surgical and postoperative care makes the additional expense of empiric bracing a suboptimal treatment strategy. Due to this clinical evidence and economic considerations, the following question must be asked: Why did my last patient leave the operating room with a brace after ACL reconstruction? This is an important question because a 2003 survey of members of the American Orthopaedic Society for Sports Medicine revealed that only 13% of respondents never braced their patients who had ACL reconstruction.[1]

Bracing after ACL injury and reconstruction is performed habitually by many surgeons and should be investigated from several angles, as the clinical question of its benefit is not completely straightforward. These decisions include prophylactic bracing for high-risk activities, immediate postoperative bracing, functional bracing during rehabilitation and return to sport, and functional bracing of the ACL-deficient knee. Each situation is a specialized area of physician and patient concern, and one answer may not fit all patients and situations. This article assesses data on empiric knee bracing after ACL injury and reconstruction to determine if it is beneficial. A Medline search was performed for ACL bracing in the areas of biomechanics, prophylaxis, and functional bracing, and relevant topics were reviewed.The Medline search was

Correspondence: Brendan D. Masini, MD,
Keller Army Community Hospital,
900 Washington Rd.,
West Point, NY,
10996.
Tel: 845-938-4734
Fax: 845-938-6808
E-mail: Brendan.Masini@amedd.army.mil

performed using the keywords *anterior cruciate ligament*, *biomechanics*, *bracing*, *prophylactic*, *functional*, and *post-operative*, as well as permutations of these terms.

Biomechanics

The biomechanical rationale for functional bracing after ACL injury should be understood before its clinical efficacy is discussed. Does the brace perform the function that the physician anticipates when he or she prescribes its use? The primary desired goal is limitation of anterior translation of the tibia relative to the femur at the knee joint in order to decrease strain on the reconstructed ACL. In turn, it should allow restoration of a symmetric gait pattern to improve patient function. Several studies have been reported to help answer these questions. A cadaver study of strain on collateral ligaments in an ACL-deficient knee in braced and unbraced conditions demonstrated decreased forces on the collateral ligaments when braced, indicating that brace use may add mechanical protection to the collateral ligaments and counteract anterior knee laxity.[2] An in vivo study of ACL strain using transducers implanted during arthroscopy compared braced and unbraced stress across the knee. This study demonstrated a protective effect of the brace at loads of up to one-third of ACL-failure loads.[3] However, the question remains as to whether the brace would continue to provide similar protection as forces increase to levels approaching tissue failure.

Proprioception is another aspect of bracing that has been well studied, with the premise that improved position sense decreases recurrent injury episodes. Wu et al[4] compared subjects treated with a functional knee brace, a placebo knee brace, and no knee brace in order to investigate the sensorimotor performance of the knee after ACL reconstruction. Proprioception improvements were found in the brace and placebo brace groups, suggesting that the benefit was not attributable to the mechanical action of the functional brace.[4] Proprioception has also demonstrated improvement with the application of a simple neoprene sleeve in uninjured subjects.[5] In a study of patients who underwent ACL reconstruction, a neoprene sleeve improved the threshold for detecting passive knee motion in the first year after reconstruction; however, at 2 years, there was no deficit in this measure, regardless of bracing.[6] Proprioception appears to be affected by bracing in the short-term, but it is unlikely that there is a difference in this measure when using a costly brace or something as simple as an elastic wrap.

Bracing is used with the goal of restoring symmetric gait; therefore, walking kinematics have also been investigated. In a comparison of patients with normal ACL function, patients with deficient ACL function, and patients who underwent ACL reconstruction, when walking on level ground with a brace, gait asymmetry in patients who underwent ACL reconstruction decreased in both the sagittal and coronal planes. These findings support the use of bracing.[7] Electromyogram and 3-dimensional kinematics of the ACL-deficient knee were performed on patients while running. Patients using a brace had decreased range of motion, increased hamstring activity, and decreased quadriceps activity at heel strike compared with the unbraced patients. The investigators concluded that the increased stability from the brace allowed these appropriate adaptations.[8] With a likely biomechanical basis for bracing reasonably established, clinical investigation of functional bracing outcomes should be examined for correlations.

Prophylactic Bracing

Prophylactic bracing has been advocated to decrease the risk of knee ligamentous injury during physical activity. The primary designs of prophylactic braces include hinged single braces or dual upright braces, which both have the primary goal of limiting valgus stress to prevent the characteristic sequence of injury to the medial collateral ligament, ACL, and posterior cruciate ligament.[9] Clinical studies have supported the use of prophylactic bracing. For example, a study of 1396 West Point cadet football players found that the injury rate was more than double in unbraced players (3.4 vs 1.5 injuries per 1000 exposures).[10] In a similar study of 987 Big Ten football players, who were stratified by position and playing condition, there was a trend toward decreased medial collateral ligament injury rate with prophylactic bracing at all positions during practice. This trend was also demonstrated among lineman, linebackers, and tight ends during games.[11] In contrast to these data, studies have demonstrated a significant decrease in athletic performance with the use of braces, including measures such as energy consumption,[12] muscular fatigue,[13] and speed and agility.[14] In a 1997 position statement by the American Academy of Orthopaedic Surgeons, which was retired in 2008, prophylactic braces were not endorsed for routine use.[15] According to the role of the team physician, it was recommended that braces could be worn, but it depended on the player's position, the level of competition, and the player's preference.[15] However, evidence does not support empiric bracing for prophylaxis in an otherwise healthy population.[15]

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Postoperative Braces

The current literature is vague regarding the timeline for transition from bracing in the postoperative period to use of a functional brace during rehabilitation and return to sport. Postoperative protocols vary, from use of a hyperextension brace,[16] knee immobilizer (Figure 1), direct application of a functional brace, to various other products, including water braces.[17] Postoperative braces are frequently worn full time during the first few weeks postoperatively, being removed only during physical therapy sessions. The argument for bracing to maintain full extension and decrease swelling and risk for arthrofibrosis is perhaps the most compelling use of bracing after ACL surgery. In a randomized trial using heel-height differences to measure extension (measurement from heel to heel with the patient positioned prone in full knee extension), a protocol of knee extension bracing at all times other than twice-daily physiotherapy demonstrated greater extension at 4 and 8 weeks postoperatively compared with the group that was allowed 0º-to-90º range of motion immediately postoperatively.[18] A similar study evaluated the use of –5º hyperextension bracing and found that there was a decreased loss of full extension compared with a 0º extension postoperative bracing protocol.[19] When swelling was measured using midpatellar circumference up to 12 weeks postoperatively and International Knee Documentation Committee (IKDC), Tegner Activity Scale, and Lysolm Knee Questionnaire scores at 6 and 12 months postoperatively, a water-filled brace was superior to a hard-frame brace.[17] Postoperative loss of motion and painful effusion may limit early rehabilitation and ultimately compromise surgical results. Therefore, bracing in the immediate postoperative period and in the transition to rehabilitation may be indicated for at-risk patients.

Figure 1. A knee immobilizer is used during the early postoperative period.

Functional Braces

There are various forms of functional braces, some of which are custom and others that are off of the shelf (Figure 2). The relative merits of each type of brace are subjective, but may be of interest to providers and patients because of the sigificant cost of some braces. In a systematic review of postoperative functional braces, Wright and Fetzer[20] reviewed randomized controlled trials, with 554 subjects identified and evaluated. Frequent outcome measures utilized in these studies included physical examination findings of instrumented laxity, isokinetic muscle testing, 1-leg hop, and range of motion. Other outcome measures included the Tegner Activity Scale, Lysholm Knee Questionnaire, IKDC, and Cincinnati scores. Of all these studies and outcome measures, the only findings that suggested superiority of bracing were from 1 study that showed increased Cincinnati patient- and physician-based knee outcome scores at the 3 months postoperatively.[19] Another study demonstrated that the brace group achieved full extension in the early postoperative period more frequently.[18] No other study showed a clinical difference with bracing or a deleterious effect, including laxity in patients with no brace.[20] Of the studies reviewed by Wright and Fetzer,[20] only 1 was prospective, with outcomes measures of subsequent injury, range of motion, heel-height differences, isokinetic strength, 1-leg hop, Lysolm Knee Questionnaire and IKDC scores, instrumented laxity, pivot-shift test, Lachman test, and brace questionnaire. At a minimum of 2 years follow-up, there were no significant differences between groups.[21] The conclusion of the systematic review was that functional bracing did not influence the clinical outcome after ACL reconstruction.[20] However, 1 population where

Figure 2. An ACL functional brace is typically prescribed after ACL reconstruction.

Abbreviation: ACL, anterior cruciate ligament.

brace wear has been supported in the literature is in skiers. A retrospective study of skiers who had previous ACL reconstruction found fewer recurrent knee injuries requiring operation in the braced group.[22] Overall, the current evidence in the orthopedic literature does not support postoperative functional bracing for ACL reconstruction. For improvements in long-term clinical outcomes, the evidence does not support empiric bracing in the treatment algorithm for most populations.

ACL-Deficient Knee

Although research on functional bracing after ACL reconstruction is well documented, treatment of the ACL-deficient knee in patients awaiting surgery or treated definitively with nonoperative management presents another dilemma. In 1 study of acute treatment of ACL-deficient knees with functional bracing compared with no bracing, there was a difference in patient subjective stability in favor of bracing. However, there was no difference in outcome measures at 6 months after injury, including the Knee Injury and Osteoarthritis Outcome Score and Cincinnati score, and there was no difference in peak torque of hamstrings or quadriceps muscle groups.[23] This was a slightly different outcome than a study of ACL-deficient skiers, in which bracing was shown to result in a statistically decreased risk of subsequent knee injury versus an unbraced group.[24] The ACL-deficient patient population presents a situation in which individual physician assessment of a patient's degree of laxity and desired activity level should guide brace recommendation.

Subjective Differences

The previously reviewed studies have demonstrated that while there is little objective clinical evidence supporting the use of functional braces, there may be some subjective benefit for certain patients. In a study comparing the use of a functional brace compared with a neoprene sleeve in patiens after ACL reconstruction, there were no differences in KT-1000 test, 1-leg hop, or Tegner score. However, at 12-month follow-up, confidence in the knee and subjective help in return to sport were rated significantly higher for brace use than the neoprene sleeve on visual analog scales.[25] As previously mentioned, one of the only measures in favor of bracing in a recent systematic review was a patient- and physician-derived subjective outcome measure (ie, the Cincinnati score) at an early postoperative time point (ie, 3 months).[17] This may be the least-scientific indication for postoperative bracing, but it may make all the difference to a young athlete attempting to return to sport after injury. Careful counseling of the patient can help clarify the role for bracing, with subjective benefit being the primary goal. An additional issue regarding this issue is the cost of bracing. Whether this cost is covered by the patient or insurance company, it is prudent to discern whether bracing is an appropriate use of medical resources.

Conclusion

The decision of whether to brace a patient after ACL reconstruction remains one that belongs to the physician in the context of each individual patient and the goals of treatment. Evidence appears to support immediate postoperative bracing with the goals of maintaining full extension and decreasing effusion. However, it is also possible that a focused physical therapy program can equally address those concerns. With the exception of a study demonstrating benefit in ACL-deficient skiers, the importance of bracing may be psychological. If a patient requires the psychological support of a functional brace as he or she returns to sport, it may be appropriate in the setting of adequate patient counseling on the lack of a medical indication and the evidence for decreased physical performance in a brace. The most important current concept for the surgeon and patient to understand is that in the context of modern graft-fixation techniques and early mobilization protocols, in most populations, empiric functional brace prescription is not indicated or required for successful long-term clinical outcomes and return to sport.

Conflict of Interest Statement

Brendan D. Masini, MD, discloses no conflicts of interes. Brett D. Owens, MD, discloses conflicts of interest with Musculoskeletal Transplant Foundation (Edison, NJ) and DePuy Mitek, Inc. (Raynham, MA).

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