The Role of Functional Knee Braces in Managing ACL Injuries

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Since the early 1980s, a substantial amount of research has gone into developing and improving knee braces for individuals with anterior cruciate ligament deficiency (ACL-D) or ACL reconstruction (ACL-R). ACL injuries occur most often in individuals between the ages of 15 and 25 years who play sports that require rapid deceleration or cutting or pivoting motions (e.g., basketball, soccer, football). Although these injuries are not as prevalent as ankle sprains, the substantially longer rehabilitation period imposes a considerable burden of lost playing time on the athlete. ACL-D and ACL-R athletes use functional knee braces (FKBs) to facilitate rapid rehabilitation and return to training and competition. The purpose of this article is to provide athletic trainers and therapists with a basic understanding of the functional, physiological, and proprioceptive effects of wearing FKBs and to provide recommendations for FKB use for individuals with ACL-D or ACL-R.

Classification of Knee Braces

In 1984, the American Academy of Orthopaedic Surgeons (AAOS) developed a position statement on knee bracing. The AAOS Committee on Sports Medicine divided knee braces into three distinct categories as described in Table 1. This article focuses on the third category of FKBs.

Custom-fit FKBs are fabricated to match the contours of an individual’s lower extremity, whereas off-the-shelf FKBs are generically designed to fit a range of lower extremity shapes and sizes. FKBs are usually prescribed by the athlete’s orthopedic surgeon or primary-care sports-medicine physician and are fitted by an orthotist or other person trained by the brace manufacturer. Fitting a custom FKB might involve making a cast of the athlete’s leg to produce a leg model to which the brace will be molded. In other cases, custom brace fabrication is based on alignment and circumference measurements of the athlete’s leg, obtained with a specially designed tool.

Custom FKBs are more expensive than off-the-shelf FKBs but are fabricated to match the exact contours of the wearer’s extremity and might be more effective. Beynnon et al., however, applied a strain transducer to the ACLs of healthy individuals and concluded that there was no apparent ACL strain-reducing benefit from custom-fitted braces over the off-the-shelf variety. France, Cawley, and Paulos concluded that the advantage of

Key Points

- Functional knee braces are commonly prescribed for ACL-deficient and reconstructed individuals.
- Functional knee braces have not been shown to limit mechanical strain on the ACL.
- There has been no consensus in the literature regarding whether or not functional braces have any beneficial muscle-activation or proprioceptive effects on the ACL-deficient or -reconstructed limb.
- The literature has suggested that patient satisfaction (i.e., symptom reduction or control) might be positively related to proper fit and hinge alignment along with the maintenance of optimal muscle tone.
- Key Words: mechanics, proprioception, patient satisfaction
custom-fitted braces might not be mechanical in origin but be related more to patient comfort and a subjective sense of improved stability.5

Biomechanics of Functional Knee Braces

The ideal FKB would allow for motion in all planes while restricting any motion beyond an individual’s physiological range. The FKB should therefore allow the athlete to aggressively compete without experiencing any subluxation episodes.4,6

FKBs operate by opposing external forces, thereby maintaining the knee joint in its proper alignment.7 FKBs are theorized to redistribute force and minimize abnormal or excessive knee-joint movement. Intuitively, one might speculate that FKBs constructed with stiffer material are better able to restrain anterior tibial displacement than are braces constructed from less stiff materials (e.g., Neoprene sleeve).7 The literature reviewed does not support this concept, however.

There are currently two basic FKB designs: the hinge-post-shell (shell) design and the hinge-post-strap (strap) design. The shell design (Figure 1) employs a semirigid or rigid plastic–carbon-fiber shell that covers a large portion of the anterior thigh and tibia.

Comparisons as to the superiority of one brace design over another are controversial. In testing anterior displacement with a knee arthrometer, Beck et al. reported that, with the exception of the DonJoy 4-Point (strap) brace, shell braces performed better than strap designs.8 Unfortunately, the authors provided no explanation as to why they thought the shell brace was superior to the strap brace. One possible explanation based on work from other researchers might be the stiffness of the brace. Branch et al. examined cutting motions in ACL-D participants wearing FKBs.9 They indicated that the joint angle, velocity, and acceleration of the knee for participants wearing a strap-type FKB were closer to those of the control participants (who had no history of lower extremity injuries) than were those of participants who wore a shell-type FKB. The authors hypothesized that those who wear a strap-type FKB might have an increased “sense of stability,” which might be related to motion restrictions that alter acquired compensatory movement strategies during cutting. Branch et al. noted that the participants who wore the strap-type FKBs also wore Neoprene undersleeves, which might have had some influence on the kinematic differences that they observed between the strap-type and shell-type FKBs. No conclusive evidence supports the superiority

### Table 1. AAOS Committee on Sports Medicine’s Knee-Bracing Categories3

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<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Example</th>
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<tr>
<td>Prophylactic brace</td>
<td>Designed to prevent or reduce the severity of a knee injury</td>
<td>Neoprene sleeve with metal hinged collateral bars and Velcro™ straps</td>
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<tr>
<td>Rehabilitative brace</td>
<td>Designed to allow protected motion of an injured knee treated nonsurgically or surgically</td>
<td>Range-of-motion-limiting brace</td>
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<tr>
<td>Functional knee brace</td>
<td>Designed to provide stability to an unstable knee during a return to stability-challenging rehabilitation or sports activities</td>
<td>Custom-fitted or off-the-shelf knee brace</td>
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The strap configuration (Figure 2) uses a rigid carbon-fiber frame.

Figure 1 A typical hinge-post-shell brace.  
Figure 2 A typical hinge-post-strap brace.