

## **Functional Knee Bracing in Sports Medicine.**

### **Introduction**

Bracing of the ACL deficient knee and the post ACL reconstructed knee is fairly common in sports medicine. Most ACL injuries are surgical candidates and the indications to operative on a torn ACL depend upon several factors:

- Age
- Activity level and frequency of sporting activities.
- Degree of laxity as measured by the KT-1000.
- Associated meniscal or chondral damage

There are a small number of patients who are copers, and can function without the use of a brace. This group is fairly small, perhaps 10% of all the patients who sustain an ACL injury. There is another small group of partial tears or single bundle tears who may be stable enough, and function at a low level of activity, to continue with conservative treatment, which may include bracing.

What are the current indications to brace after an ACL injury?

- Acute ACL injury waiting for surgery
- Chronic ACL injury that does not have significant meniscal or chondral damage and wants to continue some recreational activities.
- Post ACL reconstruction for return to sport
- Prophylactic bracing

I have had a long standing interest in the use of functional knee braces. In the 70's I was involved in the development of the Ottawa Brace. This was made from a cast of the lower leg and used orthotic principles and knee hinges from that era.



Fig 1 and 2. The Ottawa Brace – Circa 1974.

A few years later we developed the off the shelf K-99 brace. These braces both had bilateral uprights with a firm pad over the anterior tibial to prevent anterior subluxation of the tibia during activities.



Fig 3. The K-99 off the shelf knee brace circa 1979.

We then went to the DonJoy and eventually the Breg brace for function support of the ACL deficient knee and the ACL reconstructed knee.



Fig 4The DonJoy brace.

This brace uses a soft strap across the front of the tibia to prevent a-p motion. This strap must be kept tight for the brace to be effective.



Fig 5. The Breg X2K functional brace.



Fig 6. The CTI brace.

The CTI brace has been an excellent brace for skiers. However there are more fitting problems as the brace is very rigid. The rigid anterior panel is connected to the hinge and does a good job in reduced a-p motion.

This is similar in concept to the Breg X2K brace with a rigid anterior panel connected to the hinges.

With all that has been written over the past decade or two is there any evidence to use braces? This can be divided into the science and the clinical studies to answer the common questions regarding brace use.

Is there any scientific basis for this widespread use of knee braces?

**Study on three-dimensional kinematics and electromyography of ACL deficient knee participants wearing a functional knee brace during running**

Knee Surg Sports Traumatol Arthrosc Theoret, D. Lamontagne, M. Knee Surg Sports Traumatol Arthrosc 2006

Mario Lamontagne studied the 3-D kinematics and EMG data for patients running on a treadmill who were ACL deficient. He found that at heel strike there was less a-p motion and less quadriceps activity and more hamstring activity in the braced knee subjects compared to un-braced ACL deficient patients. They theorized that the brace improved the mechanics, and proprioception of the ACL deficient knee.

**The effect of anterior cruciate ligament deficiency and functional bracing on translation of the tibia relative to the femur during nonweightbearing and weightbearing**

Beynnon, B. D.Fleming, B. C.Churchill, D. L.Brown, D.  
Am J Sports Med 2003

In this study Beynnon studied both the un-weighted and weight bearing conditions as well as the transition between these 2 situations in ACL deficient patients who were braced and un-braced. The authors found that bracing the ACL deficient knee resulted in a significant reduction of antero-posterior laxity values, to a level within the limits of the normal knee during non-weight bearing and weight bearing postures. However the braces were not effective in reducing the a-p motion during the transition between non-weight bearing and weight bearing. The authors conclude that this may be why ACL

deficient patients may gain partial control of the a-p laxity, but may still have abnormal motion during sporting activities.

### **Effect of functional bracing on subsequent knee injury in ACL-deficient**

**professional skiers** Kocher, M. S. Sterett, W. I. Briggs, K. K. Zurakowski, D. Steadman, J. R. J Knee Surg 2003

Steadman identified a cohort of 180 ACL-deficient skiers was identified from a knee screening of 9410 professional skiers from 1991-1997. The authors found that a significantly higher proportion of injuries occurred in non-braced skiers compared with braced skiers ( $P = .005$ ). The risk ratio for subsequent knee injury comparing non-braced with braced skiers was 6.4 (13% and 2%, respectively)

The authors conclude that bracing the ACL deficient knee in competitive skiers was efficacious.

So to answer the question, these researchers have shown some benefit to bracing the ACL deficient knee.

The next question is the brace effective after the acute injury to the ACL?

**The effects of a functional knee brace during early treatment of patients with a nonoperated acute anterior cruciate ligament tear: a prospective randomized study.** Swirtun, L. R. Jansson, A. Renstrom, P. Clin J Sport Med

In this study Renstrom randomized patients who had an ACL tear to either a braced or non-braced group. The authors found the acute non-operated ACL patients experienced a positive effect with the brace in regards to feeling of instability and rehabilitation. The outcome measurements were visual analogue scale, Knee Osteoarthritis Outcome Score, Cincinnati knee score, a brace evaluation form, and muscle peak torque. However these outcome measurements showed no significant differences between the groups.

Now what about one of the most common uses for the brace, post ACL reconstruction. Does it work?

**Bracing after ACL reconstruction: a systematic review.** Wright, R. W. Fetzer, G. B. 2007 Clin Orthop Relat Res

This study, published in 2007, reviewed the 12 randomized clinical trials (level 1 evidence), and found no evidence that pain, ROM, graft stability, or protection from re-injury were affected by brace use.

I would like to review a couple of these well known studies.

**Is a knee brace advantageous after anterior cruciate ligament surgery? A prospective, randomised study with a two-year follow-up**

Brandsson, S. Faxen, E. Kartus, J. Eriksson, B. I.Karlsson, J.  
Scand J Med Sci Sports 2001

In this RCT Eriksson found that the outcome measurements of Tegner activity level, Lysholm score, IKDC evaluation system, one-leg-hop quotient, KT-1000 measurements and isokinetic torque showed no significant differences between the braced and un-braced group. The authors concludes that the patients who were rehabilitated with the use of a brace had less pain (based on a VAS) and a tendency towards fewer complications during the early post-operative period than the patients who were rehabilitated without the use of a brace.

**Effect of functional bracing on knee injury in skiers with anterior cruciate ligament reconstruction: a prospective cohort study**

Sterett, W. I.Briggs, K. K.Farley, T.Steadman, J. R. Am J Sports Med 2006

In this study by Steadman et al, 257 skier-employees with anterior cruciate ligament reconstruction wore braces and 563 skier-employees with anterior cruciate ligament reconstruction did not. Braced skiers had significantly higher preseason rates of grade II or higher Lachman and pivot-shift tests (braced, 29% and 22%, respectively; nonbraced, 11% and 10%, respectively). Sixty-one subsequent knee injuries were identified, 51 (8.9 injuries/100 knees/ski season) in the nonbraced group and 10 (4.0 injuries/100 knees/ski season) in the braced group ( $P = .009$ ). Nonbraced skiers were 2.74 times more likely to suffer subsequent injury than were braced skiers.

The authors conclude that because of the increased risk of subsequent knee injury in nonbraced skiers, functional bracing for skiers with anterior cruciate ligament reconstruction is recommended.

**Functional bracing after anterior cruciate ligament reconstruction: a prospective, randomized, multicenter study** McDevitt, E. R. Taylor, D. C. Miller, M. D. Gerber, J. P. Ziemke, G. Hinkin, D. Uhorchak, J. M. Arciero, R. A. Pierre, P. S. Am J Sports Med 2004

In this multi-center clinical trial at 3 military academies consisting of 95 patients with 2 year follow-up bracing was compared to the non-braced post ACL reconstruction patient. There were no statistically significant differences between groups in knee stability, functional testing with the single-legged hop test, International Knee Documentation Committee scores, Lysholm scores, knee range of motion, or isokinetic strength testing. The authors concluded that in this young healthy population there was no advantage to bracing after ACL reconstruction.

### **Knee Bracing and Osteoarthritis of the Knee**

There always has been controversy about the single versus the double upright brace to treat the varus knee with osteoarthritis of the medial compartment.



Fig 7. The single upright OA brace – The GII.



Fig 8. The double upright Breg counterforce OA brace.

My preference has always been the double upright type of brace, but this is just based on intuition, not science!

Ossur now has both the G11 and the CTI bracing lines.

Is there any science to support the use of a brace to reduce the stress in the medial compartment of the knee?

**Reduction of medial compartment loads with valgus bracing of the osteoarthritic knee.** Pollo, F. E.Otis, J. C.Backus, S. I.Warren, R. F. Am J Sports Med.2002

In this study of patients with osteoarthritis of the medial compartment of the knee it was noted that during 3-D gait analysis, valgus bracing reduced the net varus moment about the knee by an average of 13%, and the medial compartment load at the knee by an average of 11%. This reduction in load in the medial compartment also reduced pain.

The authors concluded that valgus bracing reduced the load and pain in the medial compartment of the knee.

**Knee bracing for unicompartmental osteoarthritis** Pollo, F. E. Jackson, R. W. J Am Acad Orthop Surg

Unicompartmental osteoarthritis of the knee affects millions of individuals. Most nonsurgical management of this progressive disease is primarily directed at reducing inflammation and pain with medication. Evidence supports the clinical efficacy of bracing for managing osteoarthritis of the knee. In some patients, bracing significantly reduces pain, increases function, and reduces excessive loading to the damaged compartment. A variety of health and functional status instruments, as well as radiologic techniques and biomechanical investigations, has been used to evaluate the unloading capabilities of these braces. Although changes in angulation are relatively minimal, the braces have been shown to load share and thus reduce the stresses in the degenerated medial compartment of the knee.

**The effectiveness of self-adjustable custom and off-the-shelf bracing in the treatment of varus gonarthrosis** Draganich, L. Reider, B. Rimington, T. Piotrowski, G.Mallik, K. Nasson, S. J Bone Joint Surg Am

This study compared the off the shelf unloader brace against the custom made patient adjustable valgus brace for osteoarthritis of the knee.

Ten patients compared the 2 braces one after the other for 10 weeks. The outcome measurements were the WOMAC scale and 3D motion gait analysis. Both braces reduced the pain, and improved function of these patients. The custom adjustable brace reduced the stiffness, improved function, reduced the peak knee adduction moments during gait and during stair stepping more that the off the shelf brace.

**Prophylactic Knee Bracing**



Fig 9. The Anderson Lateral knee brace.

Prophylactic knee bracing was popular for linemen in football in the 70's and 80's. Although there was some biomechanical lab data to show that off the shelf lateral knee braces provided 20-30% greater resistance to lateral blows, there was very little clinical data to support their use.

The use of knee braces, part 1: Prophylactic knee braces in contact sports [Najibi, S. Albright, J. P.](#) Am J Sports Med 2005

In this clinical study of Big Ten Conference football players Albright et al showed that during practices, there was a non-significant but very consistent reduction in injury rate for braced players in every position and string. During games, there was also a reduced rate for linemen and the linebacker/tight end group.

The authors concluded that preventive knee braces appear to offer some protection to the medial collateral ligament from a contact injury involving a valgus blow, but there may be negative effects on performance level, leg cramping, and fatigue symptoms.