[IMAGE]

Dynamic Chiropractic – May 7, 2001, Vol. 19, Issue 10

Preventing Leg Injuries

By Kim Christensen, DC, DACRB, CCSP, CSCS

Leg injuries (to the ankles, lower leg, knees, hip and thigh) affect competitive and recreational athletes alike. These injuries can interfere significantly with sports enjoyment and performance levels, and occasionally will end participation completely. Excessive pronation and poor shock absorption are underlying causes or contributing factors for many leg injuries.[1] Custom-fitted orthotics can help to improve pedal biomechanics, reduce the extent of pronation, and prevent many activity-related leg injuries.

One recent study looked at the foot biomechanics of athletes who reported recent foot or leg injuries (iliotibial band syndrome; Achilles tendinitis; stress fracture of the tibia; tibial periostitis; or plantar fascitis), and compared them to an uninjured control group.[2] The researchers determined that those athletes with more foot pronation had a much greater statistical probability of sustaining one of these five leg injuries. This helps us understand how providing appropriate orthotic support to patients involved in recreational activities can lower their likelihood of developing leg injuries.

Hip and Thigh Injuries

Many injuries experienced at the hip and thigh develop from poor biomechanics and gait asymmetry, especially when running. Smooth coordination of the muscles that provide balance and support for the pelvis is needed for optimum performance. This includes the hamstring muscles and the hip adductor muscles (groin strains), in addition to the iliotibial band. When there is a biomechanical deficit from the feet and ankles, abnormal motions (such as excessive internal rotation of the entire leg) will predispose to pulls and strains of these support muscles. The hamstrings (comprised of the *biceps femoris, semimembranosus,* and *semitendinosus* muscles) are a good example.

Hamstring Muscles

During running, the hamstrings are most active during the last 25 percent of the swing phase, and the first 50 percent of the stance phase.[3] This initial 50 percent of stance phase consists of heel strike and maximum pronation. The hamstring muscles function to control the knee and ankle at heel strike, and to help absorb

some of the impact. A recent study has shown a significant decrease in electromyographic activity in the hamstrings when wearing orthotics.[4] In fact, researchers found that the *biceps femoris* (the most frequently injured of the three hamstring muscles)[5] had the greatest decrease in activity of all muscles tested, including the *tibialis anterior,* the medial *gastrocnemius,* and the medial and lateral *vastus* muscles. The scientists in this study theorized that the additional support from the orthotics helped the hamstrings control the position of the calcaneus and knee, and absorb some of the shock of heel strike.

Knee Injuries

Except for direct injuries from contact or forced overstretch, most knee problems develop from poor biomechanics and overuse of muscles and tendons. Many of these injuries are associated with foot pronation, and can be prevented by using orthotics during sports activities.

1. Anterior Cruciate Ligament (ACL)

Epidemiology and frequency studies have now demonstrated that the vast majority of acute ACL tears occur without any contact or direct trauma to the athlete's knee.[6] Eighty-one percent of athletes with injury to the ACL recalled the moment of injury as having the tibia in internal rotation.[7] It is the torque, or twisting forces imposed on the knee joint, that causes some ACLs to rupture. Some athletes have knee joints that are more susceptible to these torque forces, and excessively pronating feet transmit more rotational force into the knee joints.

A recent study by Beckett, et al., retrospectively reviewed a group of athletes with acute, nontraumatic ACL ruptures (arthroscopically proven), and compared them to a matched control group. These researchers found excessive pronation of the foot and collapse of the arch during weight-bearing in the injured subjects, and they proposed this finding as the mechanism of injury.[8]

In their study, Beckett, et al., reviewed the biomechanics of the foot and ankle, and described how arch collapse and excessive pronation cause abnormal internal (medial) tibial rotation that "pre-loads" the anterior cruciate ligament. Normally, subtalar joint pronation and internal rotation of the tibia occur only during the initial, contact phase of gait. If pronation continues beyond the contact phase, the tibia remains internally rotated. This abnormal tibial rotation transmits excessive forces upward in the kinetic chain to the knee joint. This theory is supported by Copland's work, which found that passive tibial rotation was statistically greater in hyperpronators than in nonpronators.[9] Another study found that ruptures of the ACL

in female athletes (many of whom are at a high risk for ACL rupture) were directly correlated with the amount of arch collapse and hyperpronation.[10]

2. Patellofemoral Pain

Pain and injury at the front of the knee can occur due to patellar tendinitis or rubbing of the patella in the femoral groove. Both of these conditions can be caused by poor foot biomechanics, and are easily prevented with the use of orthotics that reduce pronation. Prolonged pronation causes excessive internal rotation of the tibia, impeding its normal external rotation during gait progression in the stance phase.[11] This excessive internal tibial rotation transmits abnormal forces upward in the kinetic chain and produces medial knee stresses, force vector changes of the quadriceps mechanism, and lateral tracking of the patella.[12] One study found that the use of soft corrective orthotics was very effective in reducing patellofemoral pain, and preventing recurrence.[13]

Lower Leg Injuries

Excessive movements of the tibia can cause injury to many of the structures in the lower leg. The muscles and tendons in the shin, the Achilles tendon - even the bones of the lower leg - are all at risk from excessive pronation. Studies have demonstrated a significant decrease in tibial internal rotation[14] and on pronation velocity[15] when using orthotics, which will help prevent injuries to this area.

1. Shin Splints

A chronic tendinitis affecting either the anterior or *posterior tibialis* muscle can present as "shin splints."[16] The anterior tibialis tendon is stressed when the foot is unable to adequately absorb the forces of foot deceleration at or after foot strike, while the *posterior tibialis* tendon develops micro-tears from attempting to stabilize excessive foot pronation.[17] Therefore, orthotics can reduce the likelihood of developing shin splint injuries.

2. Stress Fractures

Repetitive biomechanical stresses are often accentuated by inherent imbalances or asymmetries, such as hyperpronation. An example is the increased frequency of stress fractures found in the feet and lower legs of military recruits with low arches and flat feet.[18] The hyperpronating foot tends to develop stress fractures more frequently in the collapsed metatarsals and in the tibia.[19,20] Orthotic support for the arches that

includes pronation correction at the heel (a medial or *varus* wedge) will decrease the torque forces on the bones of the foot and leg and prevent the development of stress reactions. And, of course the additional shock absorption found in modern orthotics is an additional preventive factor.

Foot and Ankle Injuries

Orthotic support is most obviously able to help prevent leg injuries that affect the foot and ankle. Many injuries of this region have been found to be caused by hyperpronation, and orthotics are recommended for the associated poor shock absorption and arch collapse. These include injuries such as ankle inversion sprains,[21] heel spurs and plantar fascitis; metatarsalgia; and sesamoiditis (which can become a frank fracture).[22]

Conclusion

Excessive pronation and/or poor shock absorption have been shown to be an associated or causative factor in many leg injuries from the foot itself, up the lower leg to the knee, thigh and hip. Many of these conditions can be prevented with custom-fitted orthotics. The investigation of foot biomechanics is a good idea in all patients, especially for those who are recreationally active. Competitive athletes must have regular evaluations of the alignment and function of their feet in order to avoid potentially disabling injuries. Additional preventive measures include wearing well-designed and constructed shoes. Recommending orthotics may help prevent not just arch breakdown and biomechanical foot problems, but numerous other injuries to the lower extremities.

References

1. Dahle LK, et al. Visual assessment of foot type and relationship of foot type to lower extremity injury. *J Orthop Sports Phys Ther* 1991; 14:70-74.
2. Busseuil C, et al. Rearfoot-forefoot orientation and traumatic risk for runners. *Foot Ankle Intl* 1998; 19:32-37.
3. Mack RP. *AAOS Symposium on the Foot and Leg in Running Sports.* St. Louis: Mosby; 1982.
4. Nawoczenski DA, Ludewig PM. Electromyographic effects of foot orthotics on selected lower extremity muscles during running. *Arch Phys Med Rehabil* 1999;80:540-544.
5. Garrett WE. Muscle strain injuries. Am J Sports Med 1996;24:S2-8.
6. McNair PJ, Marshall RN, Matheson JA. Important features associated with acute anterior cruciate

ligament injury. *NZ Medical Journal* 1990; 14:537-539.

7. Arnold HA, et al. Natural history of the anterior cruciate ligament. *Am J Sports Med* 1979;7:305-313.
8. Beckett ME, et al. Incidence of hyperpronation in the ACL injured knee: a clinical perspective. *J Athl Train* 1992;27:58-62.
9. Copland JA. Rotation motion of the knee: a comparison of normal and pronating subjects. *J Orthop Sports Phys Ther* 1989; 10:366-369.
10. Loudon JK. The relationship between static posture and ACL injury in female athletes. *J Orthop Sports Phys Ther* 1996;24:91-97.
11. Zappala GG, Taffel CB, Scuderi GR. Rehabilitation of patellofemoral joint disorders. *Orthop Clin North Am* 1992; 23:555-566.
12. Tiberio D. The effect of excessive subtalar joint pronation on patellofemoral mechanics: a theoretical model. *J Ortho Sports Phys Therap* 1987; 9:160-165.
13. Eng JJ, Pierrynowski MR. Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. *Phys Ther* 1993; 73:62-70.
14. Nawoczenski DA, Cook TM, Saltzman CL. The effect of foot orthotics on three-dimensional kinematics of the leg and rearfoot during running. *J Orthop Sports Phys Ther* 1995; 21:317-327.
15. Eng JJ, Pierrynowski MR. The effect of soft orthotics on three-dimensional lower limb kinematics during walking and running. *Phys Ther* 1994;74:836-844.
16. Souza TA. *Differential Diagnosis for the Chiropractor.* Gaithersburg: Aspen Pubs; 1998, p. 313.
17. Roy S, Irvin R. *Sports Medicine: Prevention, Evaluation, Management, and Rehabilitation.* Englewood Cliffs: Prentice-Hall; 1983. 434, 438.
18. Simkin A, et al. Combined effect of foot arch structure and an orthotic device on stress fractures. *Foot Ankle* 1989;10:25-29.
19. Subotnick SI, ed. *Sports Medicine of the Lower Extremity.* New York: Churchill Livingstone; 1989, p.164.
20. Michaud TC. Recurrent lower tibial stress fracture in a long-distance runner: a case report. *Chirop Sports Med* 1988;2:78-87.
21. Heiser JR. Rehabilitation of lower extremity athletic injuries. *Contemp Podiat Phys* 1992; Aug:20-27.
22. Hartley A. Practical Joint Assessment: *A Sports Medicine Manual.* St. Louis: Mosby Yearbook; 1991, p. 571.

Kim Christensen,DC,DACRB,CCSP

Ridgefield, Washington

Click here for more information about Kim Christensen, DC, DACRB, CCSP, CSCS.

[IMAGE]