Your
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Exercise after heart transplantation

For a patient with a newly transplanted heart, the prospect of getting up and exercising may seem impossible and frightening. Yet it is not only possible for such patients to exercise (indeed, one highly motivated patient ran—and finished—the Boston Marathon 15 months after receiving a heart transplant!), it is simply good medicine. A carefully structured exercise program is one of the keys to successful recovery for these patients.

In their article, authors Nancy E. Lee, MA, PT, CCS, and David Leaf, MD, MPH, offer suggestions for developing such a program. The authors discuss the physiology of the transplanted heart, how it differs from the native heart in its response to exercise, and how the right medications and the right exercise can benefit active patients. They also establish exercise guidelines that emphasize the importance of combining strengthening and endurance exercises to help transplant patients take the best possible care of their new hearts.

Their article begins on page 6.

Gastrointestinal disorders in active people

The race begins in ten minutes. All around, the runners stretch, breathe, prepare. Absorbed in their own prerace routines, most of the runners don't even notice when number 27 sprints past them on his way to the bathroom, his third trip in half an hour.

Such scenarios are not uncommon among exercisers, especially those involved in high-intensity activities. Although for the most part, exercise is a great boon to the digestive system, "runner's trots" and other exercise-related gastrointestinal (GI) disorders have long been recognized by clinicians.

In this issue, author E. Randy Eichner, MD, FACSM, takes a practical look at managing three types of GI complaints that are commonly associated with strenuous exercise: upper– and lower–GI disorders and GI bleeding. The author notes that patients can reduce their susceptibility to these problems by changing their diet and exercise habits; he outlines these changes in a Fitness Tip for patients.

Dr Eichner's article begins on page 13.

Inside Features

Anterior cruciate ligament injuries in young female athletes

High risks call for new approaches

Mary Lloyd Ireland, MD

Anterior cruciate ligament tears are being seen with increasing frequency in women's sports, especially soccer and basketball. With expanded emphasis on women's sports now mandated at the college level, we need to focus on understanding and preventing these injuries.

Evidence is accumulating and the conclusion seems clear: Women's knees are more vulnerable to anterior cruciate ligament (ACL) injuries than are men's knees. Studies of high school, college, Olympic, and professional athletes bear this out.[1-18] Female soccer and basketball players are at particular risk, [1-4] as are gymnasts and cheerleaders.[5,6]

This injury, once thought rare in adults, is being reevaluated in light of new evidence.[7-14] Improved record-keeping for women's sports now allows epidemiologic comparisons, and the National Collegiate Athletic Association (NCAA) injury surveillance system also provides information on the rate and number of injuries per athletic exposure.[15]

In high school sports, epidemiologic statistics show that knee injuries in girls' basketball are both more serious and more common than in boys' basketball.[2,3] In fact, a San Antonio study showed that knee injuries occurred more often in girls' basketball than in boys' football (table 1).[1,2]

Similarly, NCAA surveillance data show significantly greater risk of knee injury in female collegiate basketball and soccer players than in male players (table 2).[5] A study of Atlantic Coast, Big Ten, and Pacific Ten conference athletes showed female basketball players were eight times more likely to sustain ACL injuries than were male players.[16] Studies of Olympic and professional athletes also point to higher risks for women.[4,17,18]

It's very important that the young female athlete with an acute ACL tear not return to the game or to her sport until the injury is carefully assessed. Physical exam, documentation of severity of instability, and assessment of meniscal status are essential. A repeat injury could result in irreparable damage.

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Female soccer players are at particular risk for ACL injuries.

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Why the differences?

The ACL is an intra-articular extrasynovial ligament that resists anterior tibial translation and rotation. The ACL has two bundles—the anteromedial and the posterolateral. An intermediate bundle is present in some knees.

The ACL attaches just anterior to the posterior cruciate ligament on the tibia and far posteriorly on the femur through the intercondylar notch (figure 1).[19]

In ACL injuries, lower extremity alignment, flexibility, range of motion, muscularity, and bony development set males and females apart. Women tend to have a wider pelvis, less developed thigh musculature, greater flexibility, knees that hyperextend and are in valgus, a narrow femoral nötch, external tibial torsion, and excessive foot pronation (figure 2). In a muscle-dominant lower extremity, the hamstring firing and development and strength are more important. Men tend to be muscle dominant. Women are more ligament dominant; the anterior cruciate ligament is especially important in preventing the tibia from moving forward and rotating on the femur.

Hormonal differences—especially estrogen's effect on ligaments—are presently being studied.[20] During pregnancy, hormone changes relax ligamentous structures in preparation for delivery. Anecdotal reports suggest that ACL tears tend to occur more often just before menstruation.

The femoral notch varies in shape and width, depending on the size of the ACL; a smaller ligament will have a smaller notch. However, the ratio of the notch to femoral width and the shape and distance anterior to posterior also contribute to ACL injury (figure 3). Femoral notch stenosis is believed to increase the risk of ACL tear.[21-23]

Table 1. Incidence of knee injuries in high school athletes*

	Boys' football	Girls' basketball
Number of schools	100	80
Number of athletes	4,399	890
Number of injuries	2,228	436
Injuries	**Number (%)**	**Number (%)**
Serious injuries	137	34
Surgery	97 (71)	25 (74)
Knee surgery	59 (61)	16 (76)
Cruciate injury	37 (63)	11 (69)
Injury rate per athlete per season		
Overall	0.51	0.49
Severe	0.031	0.038
Exposure per player per hour		
Overall	0.003	0.0041
Severe	0.0002	0.00035
Knee surgery rate		
Percentage number knee surgeries/ participants	0.0134	0.0180

* Adapted from DeLee and Farney[1] and Gomez, DeLee, and Farney.[2]

Table 2. NCAA reports of knee injuries, 1989-1993*

Rates of injuries (Number per 1,000 athletic exposures)

	Soccer Females	Soccer Males	Soccer F:M ratio	Basketball Females	Basketball Males	Basketball F:M ratio
ACL	0.31	0.13	2.4**	0.29	0.07	4.1**
Noncontact	0.17	0.05	3.4	21	0.04	5.3
Knee (overall)	1.6	1.3	0.2	1.0	0.7	1.4

* Adapted from Arendt and Dick.[5]
** Statistically significant ($P<.05$)

Mechanism of injury

Diagnosis of an ACL tear is best made by history and physical examination. Noncontact ACL injuries have common mechanisms. For example, figure 4 illustrates one mechanism of ACL tear in a gymnast as she landed after a tumbling run.

A witness to such an injury would probably see the athlete land with body and knee flexed from a jump and then cut or change direction. The foot stays planted, but the body flexes forward and turns in the opposite direction. The femur adducts and rotates internally. The knee is flexed and goes into valgus, the tibia rotates, and the foot pronates (figure 5). The athlete will usually fall to the floor on her back and hold her

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Figures: Courtesy of Mary Lloyd Ireland, MD

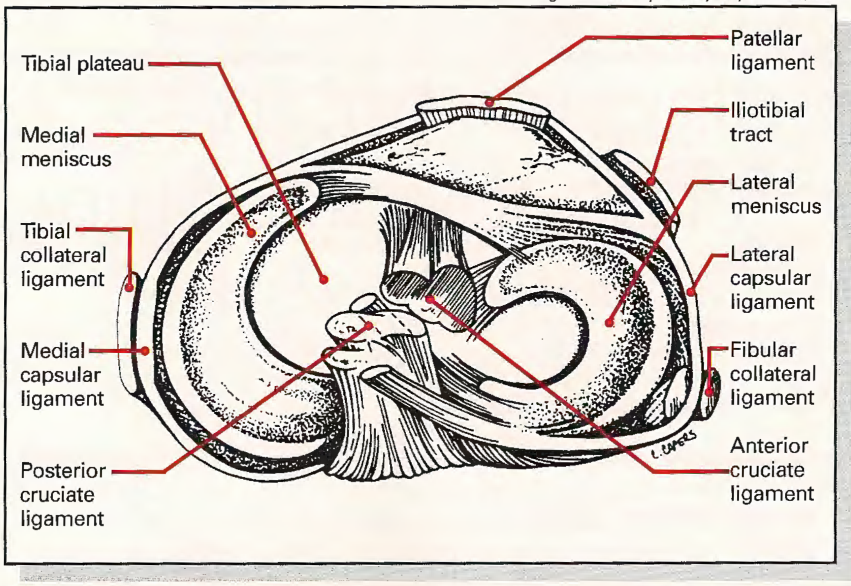

***Figure 1.** Cross-sectional view of the tibia showing the different shape of the medial and lateral meniscus and orientation of the anterior cruciate and posterior cruciate ligaments. (Adapted with permission: Baker CL [ed]. The Hughston Clinic Sports Medicine Book. Baltimore, Williams & Wilkins, 1995.)*

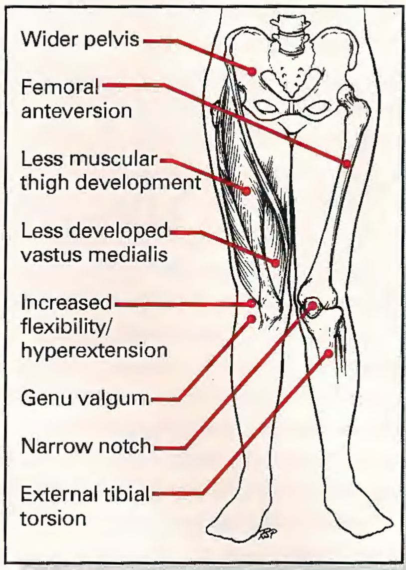

***Figure 2.** Lower extremity anatomic alignment in females. (Reprinted with permission: Fu FH, Stone DA [eds]: Sports Injuries: Mechanisms, Prevention, Treatment, 2nd ed. Baltimore, Williams & Wilkins, 1994.*

knee in a flexed position.

The athlete often says the injury felt like her knee ripped apart, exploded, "broke like a chicken bone," pivoted, shifted, or popped. It may help to remember the mechanism in terms of the mnemonics "POP" (planted, out-of-control, pop) or "VROOM" (valgus, rotation, out-of-control, momentum). A torn ACL should be first and foremost in the differential diagnosis under these circumstances. With careful history taking, diagnosis often can be made before physical exam.

Physical exam

The athlete with an acute ACL tear will usually have a moderate effusion, greater tenderness over the lateral than the medial patellar joint line, and inability to extend the knee because of hamstring spasticity. Hemarthrosis usually occurs within several hours after an ACL tear.

The Lachman test (figure 6) is the most reliable diagnostic indicator of ACL injury. Placing a rolled towel or pillow under the thigh to flex the knee about 30° allows the hamstrings to relax. An asymmetric amount of anterior tibial translation or movement without an end point can be felt when the ACL is torn. In the acutely injured knee, the anterior drawer test, done with the knee flexed to 90°, may not be as impressive as the Lachman if hamstring spasticity is present.

Usually only one pivot shift test is possible because of pain, anticipation, and apprehension. Medial or lateral joint-line tenderness and a positive bounce-home test can help document meniscal tear. However, pain over the lateral capsule may be related to shifting of the mechanism of injury rather than to a meniscal tear. Although unusual, patellar subluxation or dislocation also may have occurred at the time of injury.

Other tests

KT instrumented testing (using the KT-1000 Knee Ligament Arthrometer sold by Medmetric Company of San Diego) objectively measures anterior tibial displacement by millimeters difference. When an experienced KT examiner performs this test, meaningful differences between the injured and the opposite, normal knee can be recorded. The keys to reproducing the KT-1000 or KT-2000 numbers are relaxed hamstrings, an experienced examiner, and a cooperative patient. The test can be performed immediately after injury but is more meaningful when hemarthrosis and hamstring spasticity are resolved.

The initial exam also should include plain anteroposterior, lateral, notch view, and bilateral patellar x-rays. The Segond sign, or lateral capsular avulsion, is uncommon but indicative of an ACL tear. In the skeletally immature athlete, a tibial eminence avulsion fracture is best seen on lateral view.

Magnetic resonance imaging (MRI) can be a helpful adjunct to the physical exam but generally is not essential.[24] If the patient favors ACL reconstruction, an MRI scan probably is not needed. However, if the patient does not want surgery, MRI should be considered to make a more objective decision. If a repairable meniscal tear is seen on MRI, ACL reconstruction should be strongly recommended.

Indications for surgery

Surgical intervention is based on factors such as severity of instability, presence of pivot shift, patient demands and age, meniscal involvement, articular surface involvement, and bone bruising. Men and women do equally well after ACL reconstruction.[25]

In a ligament-dominant, young, active female athlete, strong consideration should be given to ACL reconstruction. Once a ligament has been torn, there will be more episodes of unpredictable giving way and subsequent articular surface and meniscal injury than would be expected in the more muscle-dominant male.

Reducing the risks

An important step in stemming the incidence of ACL injuries is identifying the athlete at risk. To prevent the injuries, steps can then be taken to change some drills, enhance position sense, change firing

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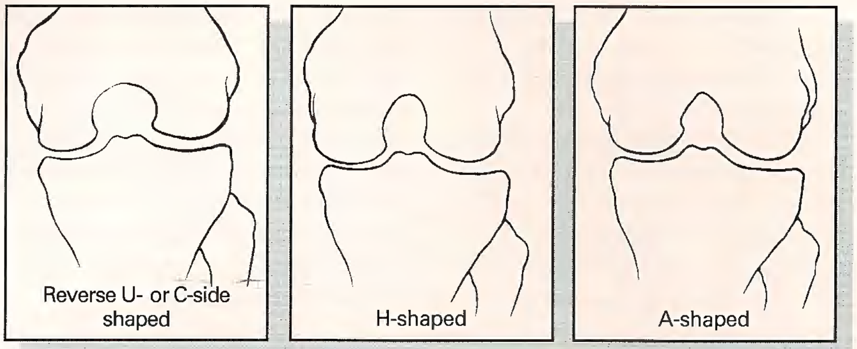

Figure 3. *Possible shapes of the femoral notch. A wider notch is less likely to impinge on the anterior cruciate ligament. (Adapted with permission: Fu FH, Stone DA [eds]: Sports Injuries: Mechanisms, Prevention, Treatment. Baltimore, Williams & Wilkins, 1994.)*

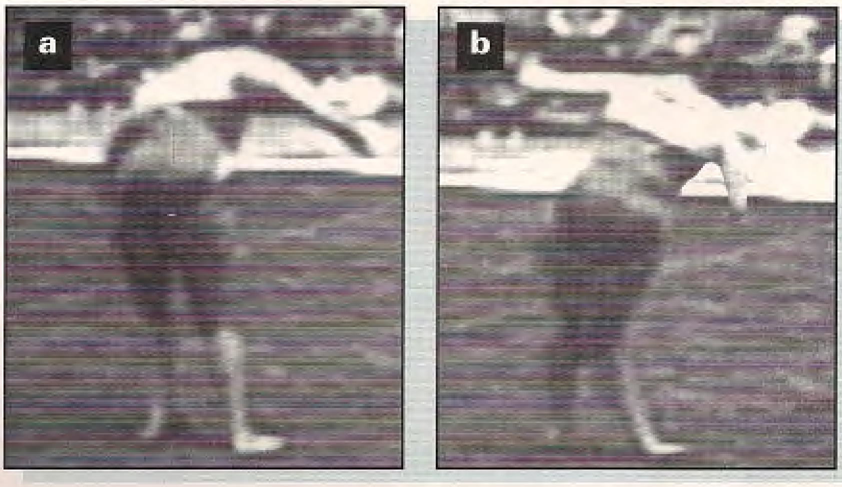

Figure 4. *The right leg is planted, body flexed, and the femur adducted and internally rotated (a). Weight is off the left leg, the right knee is in valgus stress and flexed, and the right tibia is externally rotated while the foot is pronated (b).*

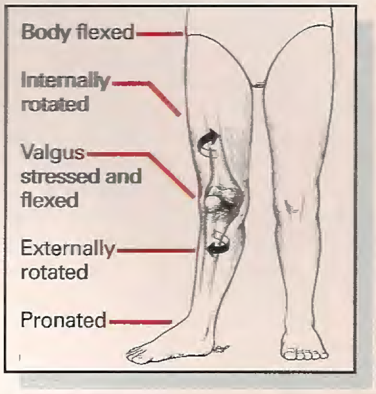

Figure 5. *Mechanism of ACL injury.*

Figure 6. *The Lachman test.*

of muscles in the lower extremity kinetic chain, and improve strength and conditioning for specific sports.[26,27]

If an athlete has torn one ACL, has generalized laxity, and is competing in a high-risk sport such as basketball, soccer, gymnastics, or cheerleading, she and her family should know she is at increased risk for injury to the opposite knee.

Coaches need to be trained to recognize risks and to change training programs when appropriate. For example, in basketball the most common mechanisms of injury are plant and cut, straight leg landing, and one-step stop.[26] Modifications of these specific moves, landing with the knee more flexed on both feet, and rounding turns in a three-step stop may reduce the risks.[26]

As more emphasis is placed on the female athlete, more research will be needed.[28] Unfortunately, female athletes do not yet have the financial and overall support afforded male athletes.[29] This situation needs to change. The message cannot be "girls should not compete in high-risk sports such as soccer and basketball." As healthcare providers, we must design prevention programs to serve all athletes.❑

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