



CLINICAL EXERCISE SPECIALIST MANUAL

A Fitness Professional's Guide
to Training People with
CHRONIC DISEASE

J. DANIEL MIKESKA DHSc

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**A FITNESS PROFESSIONAL'S GUIDE TO
EXERCISE AND CHRONIC DISEASE**

BY J. DANIEL MIKESKA, DHSC

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CHAPTER 20

COMMON KNEE DYSFUNCTIONS

By the end of this chapter you will understand:

- Anatomy
- Pathologies
 - o Patellofemoral pain syndrome
 - o Meniscus tear
 - o ACL rupture
 - o Knee replacement
- Treatment options
 - o Early intervention
 - o Exercise intervention
 - Mobility/stability
 - Movement
 - What to avoid

Anatomy

The knee is a complex hinge joint that allows for 6 degrees of freedom; 3 rotational, and 3 translational motions. The tibiofemoral joint is where the distal portion of the femur articulates with the proximal tibia. The patellofemoral joint is where the patella (kneecap) and femur meet. The knee joint has four

main movements; flexion, extension, medial rotation, and lateral rotation, with lateral and medial rotation occurring only when the knee is flexed.

The knee has five main ligaments and two menisci. The menisci are c-shaped, fibrocartilage structures attached to the medial and lateral ends of the intercondylar area of the tibia (Figure 20.3). They help stabilize the knee by deepening the articular surface of the tibia, they increase surface area that dissipates shock and force, and because of the location of mechanoreceptors, help with proprioception (Fox, Bedi, & Rodeo, 2012). The ligaments are:

- Patellar ligament is the distal portion of the quadriceps femoris tendon that connects to the patella and the tibial tuberosity.
- Medial collateral ligament (tibial) attaches to the medial epicondyle of the femur and the medial condyle of the tibia.
- Lateral collateral (fibular) ligament attaches to the lateral epicondyle of the femur and on the lateral surface of the fibular head
- Posterior cruciate ligament (PCL) attaches at the posterior intercondylar of the tibia and anteromedial femoral condyle.
- Anterior cruciate ligament (ACL) attaches at the anterior intercondylar of the tibia and posteriorly on the medial surface of lateral condyle of the femur.

The collateral ligaments stabilize the hinge motion and prevent excessive medial and lateral rotation. The PCL prevents posterior dislocation of the tibia with the femur, and the ACL prevents anterior dislocation of the tibia with the femur. Figure 20.1 details knee anatomy.

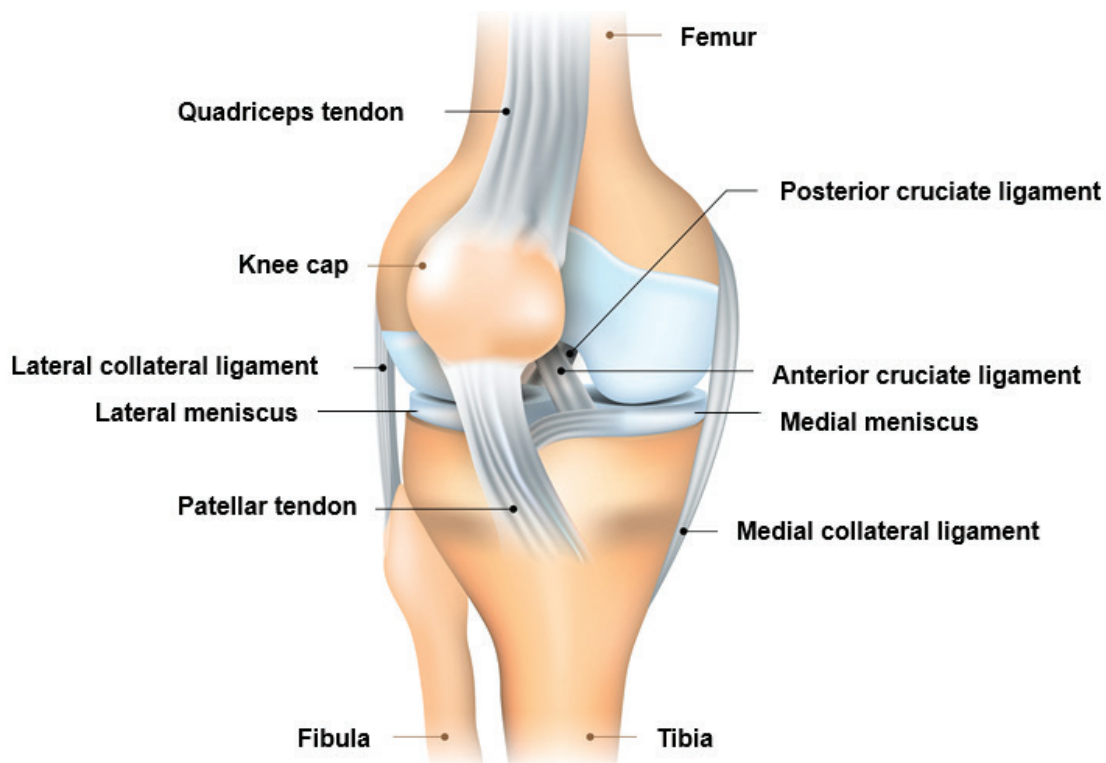


Figure 20.1 Diagram of front right knee

Patellofemoral Pain Syndrome

Patellofemoral pain syndrome (PFPS) is characterized by stiffness and pain during or following squatting, lunging, climbing or descending stairs, prolonged sitting, or running (Cheatham, 2015; Dixit, Difiori, Burton, & Mines, 2007). Popping, catching, or clicking sensations have also been associated with PFPS as the kneecap moves in and out of the trochlear groove. Swelling of the knee, instability, or locking **are not** characteristic of PFPS, and because PFPS is just one possible diagnosis for knee pain (some other possibilities are listed below), it is imperative a client presenting with knee pain consult a physician.

Possible causes for anterior knee pain:

- Tumor
- Iliotibial band syndrome
- Osgood-Schlatter disease
- Patellar bursitis
- Quadriceps or patellar tendinopathy
- Patellar instability/subluxation
- Chondromalacia patellae

Often referred to as *runner's knee* or anterior knee pain, PFPS is a common diagnosis for patients presenting with knee pain, and the most common diagnosis for runners (Bolgla & Boling, 2011; Dixit et al., 2007). Common risk factors for PFPS are overuse, trauma, muscle dysfunction (overactive and under active muscles), and structural or anatomical abnormalities. Sudden training program changes such as increased frequency or intensity can contribute to tissue damage, joint injury, and pain. Repetitive loading can lead to overuse injuries of the knee. Running, climbing stairs, hill ascending and descending, and jumping are all activities that can lead to PFPS.

Because the knee is the crossing point between the hip and ankle, over and underactive muscles from the hip, upper leg, and lower leg can cause abnormal movement patterns that disrupt normal knee function (Sahrmann, 2011). Due to the connection, via fascia, between the iliotibial (IT) band and the knee, an overactive IT band complex can pull the knee laterally. Therefore, flexibility in the IT band complex should be assessed. Underactive knee extensors and external hip rotators are associated with patella tracking dysfunction, knee valgus and excessive pronation suggests strengthening the entire quadriceps group, as well as the hip complex via extension and abduction may be beneficial. Keep in mind, although strengthening the quadriceps is the gold standard for restorative exercise for PFPS, the flexibility of hamstrings, hip flexors, and gastrocnemius should be assessed and treated to avoid excessive contact between the patella and femur because of increased posterior force. Restoring neuromuscular control of the hip complex should be part of the initial focus of restorative exercise (Bolgla & Boling, 2011; Cheatham, 2015; Dixit et al., 2007).

Q-angle

Although structural and anatomical abnormalities is out of the scope of practice for a CXS, it is important to know how biomechanical dysfunctions can affect movement patterns. The Q-angle is the measurement between the quadriceps muscles and the patella tendon. To determine the Q-angle, draw a line from the anterior superior iliac crest to the center of the kneecap, and another line from the center of

the kneecap to the tibial tuberosity as shown in Figure 20.2. The Q-angle is important; it is thought to reflect of the effectiveness of the pull of the quadriceps on the patella: the greater the angle, the less effective the pull, as well as increased knee adduction and foot pronation. This has come under scrutiny as of late, and although it may be implicated in some knee conditions, it is important to remember the Q-angle cannot be changed. Therefore, a more effective approach is to correct the increased femoral and tibial internal rotation and femoral abduction (Bolgla & Boling, 2011). Flat feet and high arches (pes planus and pes cavus), have also been associated with PFPS. Clients with flat feet may compensate for a lack of foot stability by presenting with increased tibial and femoral internal rotation. Similarly, high arches cannot provide proper cushioning or reflexive mechanical energy assistance during loading activities such as jumping or running. In addition to restoring flexibility and strength, stability and mobility training should also focus on restoring neuromuscular control to the hips, knees, and ankles; movement training should focus on progressive functional exercises to improve ADLs. Suggestions for working with clients who have been diagnosed by a physician with PFPS are in Table 20.1.

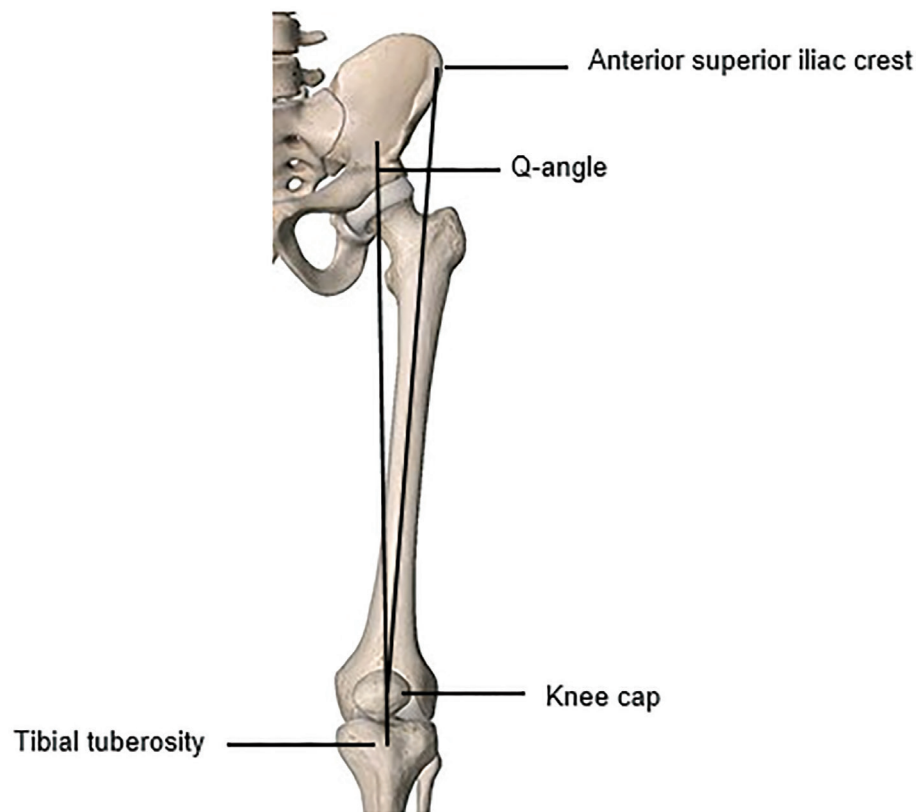


Figure 20.2 Diagram of the Q-angle.

Meniscus Injuries

Meniscus injuries can be either acute (traumatic) or chronic (degenerative), and occur when fibrocartilage tears or splits, usually due to axial loading and rotational force that create a shearing force across the tibiofemoral compartments of the knee (Doral, Bilge, Huri, Turhan, & Verdonk, 2018; Pekkerman, Ralhan, & Chang, 2017). It is important to remember menisci are part of a complex network of ligaments and bony attachments and should not be treated as separate structures. Furthermore, while at

birth, each meniscus is vascularized, by adulthood, only 10-30% of the meniscus outer periphery, or red zone, has blood flow as diagrammed in Figure 20.3.

Signs of a meniscus tear are knee pain, stiffness, clicking, popping, catching, locking, swelling, and muscle weakness (Cheatham, 2015). Risk factors for meniscal tears are age > 60, male, active work involving squatting, kneeling, or climbing stairs, the sports of soccer and rugby, and waiting >12 months after ACL injury and corrective surgery (Doral et al., 2018). Tears are generally described by location and type and include vertical longitudinal tears that can degenerate into a bucket handle, oblique, transverse or radial, horizontal tears that run parallel to the tibial plateau and can lead to a flap tear, meniscal root tear or avulsion that occur near the root insertion, and complex or degenerative tears that are a combination of tear patterns, as detailed in Figure 20.3. The most common traumatic tears are longitudinal-vertical and the most common site for tears is the posterior horn on the medial meniscus. Tears in the vascular zone often heal faster than tears in the avascular zone, and may heal spontaneously (Howell, Kumar, Patel, & Tom, 2014). The most common side effect resulting from a meniscal surgery is osteoarthritis.

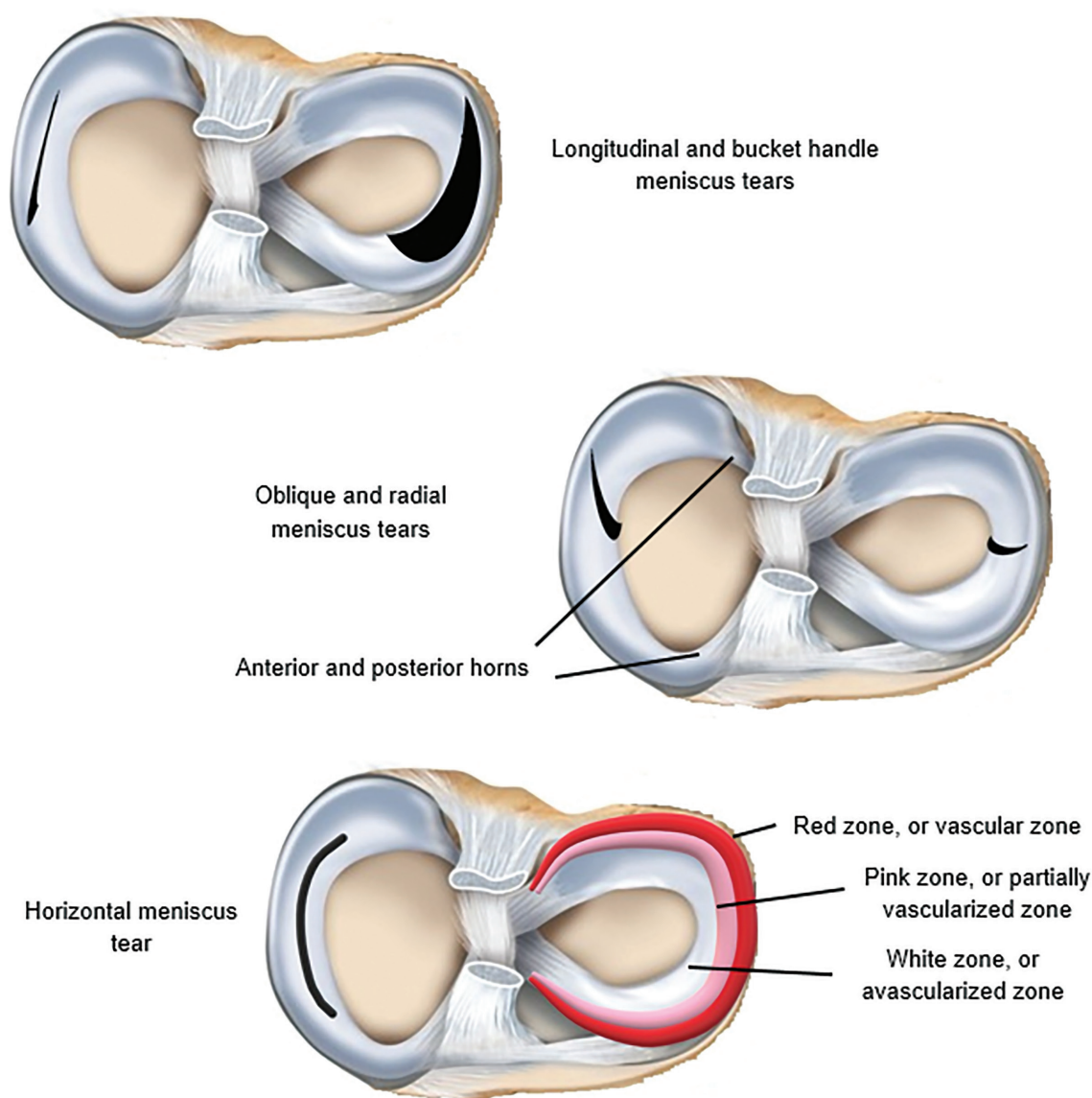


Figure 20.3 Diagrams of common meniscus tears and *vascularization*.

Immediately post-injury, protection, rest, ice, compression, and elevation are recommended with anti-inflammatory and analgesic medications. For the first 6 months activity modification with an unloader-brace is suggested as is quadriceps strengthening. If non-operative management fails to relieve symptoms, surgery should be considered (Cheatham, 2015; Doral et al., 2018; Howell et al., 2014). Surgery may involve partial or complete removal of the meniscus or suturing the torn fragment. Removal can lead to joint degeneration and repairs are most effective if a tear is in the vascular zone.

A CXS may work with a client who had a partial or complete meniscectomy 4 weeks post-surgery or a client who had a meniscus repair 12 weeks post-surgery. Early physical therapy intervention consists of quad sets, straight leg raises (SLR), heel raises, balance, and flexibility. Mid-phase rehab includes light leg press, step-ups, calf raises, and partial squats. Range of motion (ROM) should not be attempted until swelling is minimized and 110 degrees of flexion is reached. Late-phase rehab is dedicated to continuing the progress and achieving activities of daily living (ADLs). You must consult with a physical therapist and/or physician prior to starting a training program. Restorative protocols are in Table 20.1.

ACL Injuries

ACL injuries and rupture account for 100k-200k knee injuries annually in the United States and because of differences in hormones, biomechanics, and neuromuscular adaptation, females have an injury rate up 3.5 times that of males (Friedberg, 2019; Hansen, 2018; Voskanian, 2013). A majority of ACL ruptures result from non-contact sport injuries caused by improper body mechanics and a lack of neuromuscular control (Cheatham, 2015; Friedberg, 2019; Hewett, Di Stasi, & Myer, 2013). The primary mechanism for ACL injury is multi-planer movements such as side stepping, pivoting, or twisting, while decelerating (Cheatham, 2015). The immediate signs of an ACL rupture are swelling, knee instability, decreased ROM, and pain. Additionally, many patients hear a pop at the time of injury.

The goal of early ACL treatment is to restore a normal gait and ROM. If a patient has no other associated knee injuries, non-operative treatment may be beneficial. Non-operative treatments include activity modification with the elimination of cutting and pivoting movements and use of a protective knee brace. Therapeutic interventions include strengthening the muscles around the knee, cryotherapy and compression, and ROM and neuromuscular training (Paterno, 2017).

It is suggested if non-operative treatment does not resolve symptoms at 6 months, surgical intervention should be considered. Unfortunately, less than half of ACL reconstruction patients return to sport in the first year, and up to 25% will re-rupture the ACL (Hewett et al., 2013). ACL reconstruction involves replacing the ligament with a graft. An autograft uses the patient's own tissue while an allograft uses donor tissue. The patellar tendon, the gracilis tendon, or the semimembranosus tendon can be harvested from a patient and used as an autograft. Autografts include two surgery sites, the ACL and the site from the harvest, which may result in harvest site pain and joint laxity (Cheatham, 2015; Ekdahl, Wang, Ronga, & Fu, 2008). Allografts can be donor tendons from the Achilles, anterior tibialis, or patella. The advantage of an allograft is only one surgical site, but graft lengthening may occur causing joint laxity. Regardless of the graft type, ACL healing time is the same and follows the same process; avascular necrosis, re-vascularization, and tissue remodeling, and generally takes up to 12 months for a reconstructed ACL to mature (Cheatham, 2015; Ekdahl et al., 2008).

A CXS may start working with an ACL patient as soon as 12 weeks post-surgery. However, it is recommended a client have the quadriceps strength and ROM to perform some ADLs without a brace or crutches. Closed kinetic chain (CKC) movements stimulate proprioceptors, reduce acceleration forces, and encourage joint stability, while open kinetic chain (OKC) movements increase shear force across the

knee joint. Therefore, it is recommended to start with CKC and progress to OKC, while keeping CKC movements to <90 degrees of flexion. Protocols for exercise training are in Table 20.1.

Total Knee Replacement

The incidence of total knee replacement, or arthroplasty (TKA), has increased over the last decade, with an estimated 4.5 million Americans living with TKA, and the incidence increase is expected to continue (Mayo Clinic, 2019). If one of the three components of the knee (femoral, tibial, or patellar), is damaged or arthritic, and physiotherapy or medical treatments such as anti-inflammatories, pain relievers, or bracing or assistive devices do not resolve symptoms a TKA, or a partial replacement may be necessary. During TKA all three components are replaced with plastic or metal; in a partial knee replacement, only one component is replaced. A TKA is preferred over a partial replacement because the components last longer and if two or more of the compartments are damaged, a TKA will need to be performed anyway (Cheatham, 2015).

There are no specific precautions or standardized rehabilitation guidelines, but it is recommended exercises should focus on reducing swelling, improving ROM, increasing knee and hip strength and proprioception, and restoring ADLs (Cheatham, 2015 Mistry et al., 2016). Particular focus should be given to the quadriceps as diminished muscle activation and weakness are known deficits following TKA. Additionally, because of surgery and motor control dysfunction, the quadriceps, hamstrings, and calves often become tight, so stretching the lower extremities is a common focus of restorative exercise post-TKA. Cardiovascular exercise should begin at a basic level and progress slowly. Aquatic exercise is a good place to start as it provides a non-weight bearing, buoyant medium to alleviate joint stress (Mistry et al., 2016). Exercise activity can begin at 6-12 weeks, and a CXS should consult a client's physician and physical therapist for specific guidelines. General restorative exercise guidelines are in Table 20.1. For a detailed list of rehabilitation guidelines, see Appendix 2 in Mistry et al. (2016).

Table 20.1

General activity guidelines for common knee dysfunctions

Condition	Early intervention	Stability/mobility	Movement	Avoid
PFPS	Modify activities to avoid pain Get fitted for footwear Braces, supports, orthotics Taping Anti-inflammatories	IT Band stretching and SMR Posterior chain stretching OKC quad movements: Straight leg raises Terminal knee extensions Leg extension between 90-60 degrees CKC movements for functional activity as tolerated Partial squat Side steps Step ups	Progressive functional exercises to improve ADLs, core, and balance. Wall squats Leg press Multi-directional lunges Side steps Start in bi-lateral stance Followed by staggered and monoped while decreasing stability Cardiovascular exercise should include low-load-ing exercises such as water aerobics and bicycle	Prolonged sitting with knees flexed Running Jumping Squats CKC movements between 30-60 degrees OKC movements between 25-0 degrees

Meniscus injury	Intervention following surgery depends on the type of surgery. Removal allows for a more aggressive approach than a repair. Bracing and non-weight bearing OKC exercises with some restrictions on ROM. Flexion to 90 degrees Extension to 30 degrees Light leg press to 10 degrees of ext.	Continue progress made in physical therapy Improve stretching for muscles that cross the knee: Hamstrings Quadriceps Neuromuscular training—balance progression	CKC movements start at <45 degrees and progress to 90 degrees; Leg press Squats Lunges Abduction/Adduction Leg ext. 90-60 degrees	Deep squats Pivoting Cutting Leg flexion past 90 degrees (lunges, leg press, etc.) Knee hyper extension Plyometrics
Knee replacement surgery	Physical therapy for 6-12 weeks Reduce swelling Increase knee and hip strength Improve balance and proprioception Begin restoration of ADLs	Flexibility throughout the hips, thighs, and calves pain free with a controlled ROM Gait training Neuromuscular training—balance progression SLR Quad sets	Low-load OKC exercises, SLR, and extension and flexion between 90-60 degrees CKC exercises from 0-45 degrees to start and progressing to 90 degrees Leg, press Wall squats, Multi-planer lunges,	High intensity movements until a base of strength and control has been established. Jumping Running Skiing Racquet sports Contact sports

Cheatham, 2015; Mistry et al., 2016; Saka, 2014; Stensrud, Roos, & Risberg, 2012

Discussion and application

1. What are the causes and signs of patellofemoral pain syndrome? What are the goals of a restorative exercise program, and what are some contraindications?
2. Describe the first few weeks of rehabilitation following meniscus surgery. At what point is it appropriate to begin working with a fitness professional as opposed to a physical therapist?

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