THE KNEE

The knee joints are the most used and frequently the most abused joints in the body. As a result, knee injuries are quite common. When a knee injury has occurred, and it is treated properly, the body has an amazing capacity for overcoming even the most serious damage!

A joint is any point in the body where two bones meet. Cartilage covers the ends of the bones where they make contact with each other. Cartilage is tough, elastic tissue that provides a smooth, slippery surface between the bones; it reduces friction and keeps the bones from grinding against one another as they move. It also acts as a shock absorber. When the joint is healthy, the bones meet and the cartilage ends glide against one another with nearly friction-free motion. A clear example of cartilage can be seen when breaking off a thigh bone on a roasted chicken. The super-smooth, bluish-white material on the end of the bone is joint cartilage.

Generally, the end of one bone is convex in shape (ball-like or round in shape) matching perfectly with a concave shape (socket shaped) on the other bone. Most of our joints are some variation of this ball and socket arrangement. Technically, the knee is a hinge-type joint, but it acts much like a ball and socket.

The bottom of the thigh bone (femur) fits into a socket on the top of the shin bone (tibia). The ends of both bones are covered with cartilage where they make contact. In the knee joint there is also semicircular cartilage called the meniscus cartilage. The meniscus sits on top of the shin bone cartilage and acts as a rim around the edge to deepen the socket.

The joint is then enclosed in a "sac" called the joint capsule. The joint capsule contains synovial fluid which carries nutrients to the cartilage and acts as a lubricant to further reduce friction.

The ligaments are strong bands of flexible cartilage-like material that cross the joint, hold the opposing bones together, stabilize the joint and help limit its range of motion. They often look like white nylon straps.

Muscles taper on both ends into thin, tough bands called tendons. The muscle tendons cross the joint over the ligaments. The tendons attach the ends of the muscle to the bones on either side of the joint. They look very much like ligaments and are composed of similar, tough material. The muscles create movement, pulling the joints together in the process, and they are the primary system for maintaining a tight fit. In addition, they reinforce the joints and also act as shock absorbers.

Our knee joints, like the ball joints in a car suspension system, are designed to function best and last longer when they fit tightly together. As in a car, our joints will wear much more quickly when they begin to loosen as a result of our muscles becoming weaker.

COMMON KNEE PROBLEMS:

ARTHRITIS: The cartilage is the primary area affected by the most common form of arthritis: osteoarthritis. The super smooth surfaces of the cartilage become rough and worn. In some cases the cartilage wears through completely, and the bones begin to rub and grind against one another.

Cartilage gets its nutrients from the synovial fluid, which surrounds the joint. Exercise is a requirement for healthy cartilage because the movement it produces forces synovial fluid into and out of the cartilage (like rinsing out a sponge in water). Inactivity actually starves the cartilage causing its deterioration and the development of osteoarthritis! The new research clearly shows that knees become arthritic from lack of use, not from too much use!

Almost everyone will have some traces of arthritis as they mature, but this doesn't mean that it has to be painful. In some cases even when an x-ray clearly shows the cartilage is worn completely through, and it is bone on bone, there is no pain!

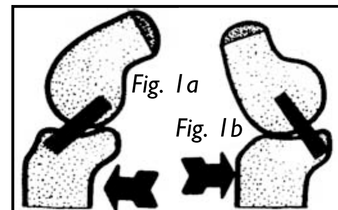
Dr. Harry Lodge, author of the best selling book, ***Younger Next Year,*** and a highly respected expert on aging, says the key to eliminating joint pain is strengthening exercise. As we age and the muscles become weaker, the joints loosen up, and he states that this is the major reason for joint pain. When the strength is rebuilt, the pain often goes away. In fact, he says that in most cases when he sees a person who is recommended for knee replacement, he has them begin strengthening exercises for the muscles that support the knee and "60% of the time I never see them again!" ***(For more information regarding arthritis, please see our Arthritis brochure.)***

CARTILAGE: One of the most common knee injuries is torn or frayed cartilage. Cartilage will sometimes heal, depending on the location and severity of the injury. Cartilage is white in appearance because of its limited blood supply. As previously discussed, it gets its nutrients from the synovial fluid that surrounds it. During exercise synovial fluid is moved in and out of the cartilage delivering the necessary nutrients. Strengthening exercise also promotes growth and the healing process in the cartilage. Once your doctor has approved exercise, all the muscles that support the knee should be worked through a pain-free range of motion.

Many people have also found glucosamine sulfate supplements helpful when combined with strengthening exercise for reducing knee pain resulting from cartilage problems.

BURSITIS: The bursa are little sacs that form slippery cushions between moving parts in or around the joints. Their task is to prevent wear on the different structures that glide against each other. They also produce synovial fluid which lubricates the knee joint. When the knee is subjected to severe stress or trauma, the bursa can become sore and inflamed (bursitis). The bursa may react by producing extra quantities of synovial fluid, causing swelling of the knee joint (water on the knee). Strengthening the muscles that support the knee, working within a pain-free range of motion, will promote healing.

LIGAMENTS: Ligaments, like cartilage, tend to heal very slowly when injured because of their limited blood flow. There are four primary ligaments of the knee. The lateral collateral ligament located on one side of the knee and the medial collateral ligament on the other side. The anterior (figure #1a) and posterior (figure #1b) cruciate ligaments are located under the knee cap inside the knee and limit the forward and back movement of the shin bone (tibia bone) to keep it aligned with the thigh bone (femur bone).



Figures #1a & #1b: The prime function of the cruciate ligaments

Over a lifetime of activity, the ligaments tend to stretch. Not even surgery will return a ligament to 100% of its original tightness or strength! As a result, the ligaments do not hold the joint together as tight as it should be. The more laxity or "play" there is in a joint, the greater the risk of reinjury. Increasing the strength of the muscles that support the knee to a higher degree than their pre-injury level can compensate for damaged ligaments and cartilage.

TENDONS: The tendons are the bands of cartilage-type connective tissue that attach the ends of the muscles to the bones. Inflammation of a tendon from overuse or impact is called tendonitis. The tendons are white in appearance because of their limited blood supply. This limited blood supply hinders the healing process when injured! Strengthening exercises for the muscles surrounding the affected area stimulate growth and the healing process in the tendons. Care should be taken to perform only pain-free movement!

The key to knee rehabilitation is to strengthen the muscles that cross the knee joint. The strongest muscle group that crosses the knee is the quadriceps, on the front of the thigh. The "quads" are a group of four muscles: the rectus femoris, vastus medialis, vastus lateralis and the vastus intermedius.

The four muscles of the "quads" converge into a tendon that attaches to the knee cap and continues on attaching to the shinbone just below the knee cap.

The knee flexors (hamstrings) cross the knee on the back of the thigh. Three muscles make up this group: the semitendinosus, the semimembranosus and the biceps femoris. They attach on the pelvis bone, run down the back of the upper leg, cross the back of the knee joint and attach to the lower leg bone (tibia).

The calf muscle (the gastrocnemius) also crosses the back of the knee and lends further support to the joint. (fig. #2)

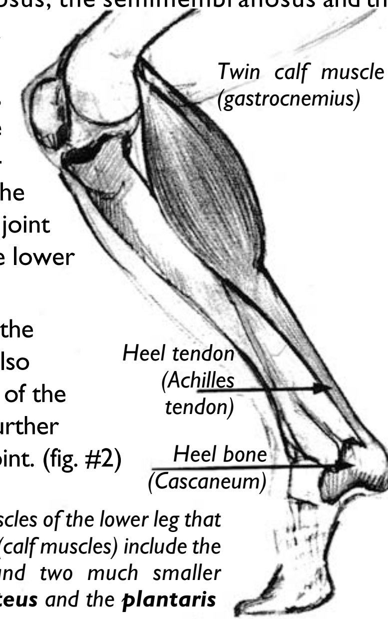


*Figure # 2 The muscles of the lower leg that cross the knee joint (calf muscles) include the **gastrocnemius** and two much smaller muscles, the **popliteus** and the **plantaris***

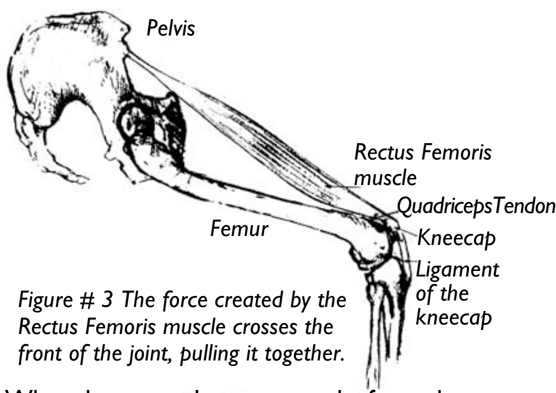


Figure # 3 The force created by the Rectus Femoris muscle crosses the front of the joint, pulling it together.

When these muscles contract, the force they create pulls the knee joint firmly together. (fig. #3) The stronger the muscles are, the tighter the joint is held together and the less vulnerable it is to injury. Even when relaxed, these muscles maintain a constant tension pulling the joint together. The stronger the muscles are, the more tension and support they provide to the knee and the less vulnerable to injury. Strengthening the muscles around the knee effectively provides an internal "knee brace" which is far superior to any externally worn brace.

Anyone participating in activities where high stress or impact is possible should be particularly concerned with maintaining muscle strength.

Dr. Richard Steadman of Vail, Colorado, is one of the most highly respected knee surgeons in the world. He insists that his patients' commitment to rehabilitation, more than any skill of his own, is the key to their success! Dr. Steadman believes that movement helps healing and his approach has proven to be remarkably effective. Studies have shown that immobilization of an injured joint has adverse effects on the joint, and the scar tissue that forms actually eats into the articular cartilage. Before surgery is even considered, he sends 70% to 80% of his patients to rehabilitation.

In one of Dr. Steadman's most renowned cases, he operated on an Olympic skier who had nearly severed his lower leg at the knee in a crash. All but one ligament had been torn away. According to Dr. Steadman, he would have considered the surgery a success if his patient would have eventually been able to tread water; but "Marc pushed the limits more than anyone else," and aggressively rebuilt his leg strength.

Marc Girardelli came back to win the world cup slalom title the very next year, the overall World Cup title four times since then, eight World Championship medals and the 1992 Olympic silver medal in the Giant Slalom! Dr. Steadman credits Marc's fanatical rehabilitation as the key factor that made this extreme case possible!

The muscles are the only support structure of the knee that can be easily and quickly strengthened. As the muscles get stronger, the bones and all the connective tissue will strengthen (but at a slower pace than the muscles).

The potential for rapid increases in muscle strength at any age were dramatically demonstrated by Dr. William Evans of Tufts University in Boston. Using ordinary weightlifting machines, he and his staff were able to double the leg strength of a group of 86 to 96 year olds in just eight weeks!

Increased muscle strength is the most important thing that can be done to prevent injury or reinjury. Joint injuries occur when the joint is exposed to a force that exceeds its "breaking point." Increased muscle strength simply raises the "breaking point" of the joint. The stronger the joint, the less likely it is to confront forces that exceed its breaking point.

It is very important to strengthen all the muscles that support the knee joint and maintain muscle balance. When the muscles on one side of the knee joint become disproportionately stronger than the muscles on the other side, precise muscle coordination is hindered, and this can cause injury or unusual wear of the cartilage. To prevent muscle imbalance, a full body balanced strengthening program, such as the MedX circuit is essential.

WHAT TO DO FOLLOWING AN INJURY?

Once your doctor has given permission to begin exercise, the initial goal for knee rehabilitation is to work with our trainers and find a series of pain-free exercises for all muscles that cross the joint. The goal is to carefully strengthen the muscles in the area of the injury, limiting each exercise to a pain-free range of motion. Initially, the range of motion may be very short, perhaps only a matter of inches. However, it is critical that the movement is stopped before the point of pain or discomfort to avoid further aggravation of the condition.

Ideally, leg extension exercises should be performed on the MedX leg extension machine for the quadriceps, the MedX leg curl machine for the hamstrings and the calf raise for the calf muscles. Each exercise should be performed through whatever range of motion can be done *without pain*! Gradually the range of motion and resistance should be slowly increased when possible. As strength increases, the pain free range of motion may also increase. If pain develops at any time, the resistance and the range of motion should immediately be decreased to pain-free levels and should continue at that level for at least a few weeks before small increases are again attempted. Patience is the key to successful rehabilitation.

Leg extensions and leg curl exercises are very important for the knee and preferable to using a leg press machine because they are full range exercises. Full range exercise strengthens the knee in all its possible positions, which is important for prevention of future injury. The leg press only increases muscle strength in a limited portion of the knee movement, leaving weak areas that are vulnerable to reinjury.

Strengthening is a drug-free and nonsurgical approach to healing. In most cases, it is recommended before surgery. Even if surgery is eventually required, increased muscle strength is essential because the postsurgery recovery period can cause rapid deterioration of the muscles. The stronger the muscles are prior to the surgery, the stronger they will be following any inactive recovery period; plus the stronger the muscles, the faster the healing and the less likely reinjury will occur.

HOW LONG SHOULD STRENGTHENING BE CONTINUED?

With strengthening exercise, on the MedX equipment, strength will begin to increase immediately. If the exercises are discontinued or they are done sporadically, strength will decrease, and the integrity of the joint will also decrease.

When all goes well and discomfort in the joint disappears, the temptation is to say "it's healed" and to discontinue the exercises. This will lead to muscle weakening, even in an active person. Weaker muscles, coupled with the structural weakness from the injury, create a situation where another injury is more likely to occur. The good news is that it's relatively easy to maintain strength. When done correctly, even a once a week strengthening program will maintain leg strength.

Mike Arteaga
Owner, founder (1973), Health and Fitness Consultant

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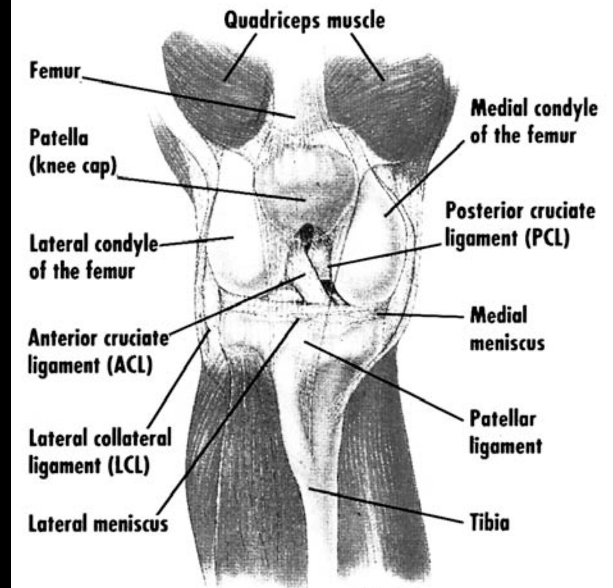

ANATOMY OF A RIGHT KNEE
(Viewed from the front)

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