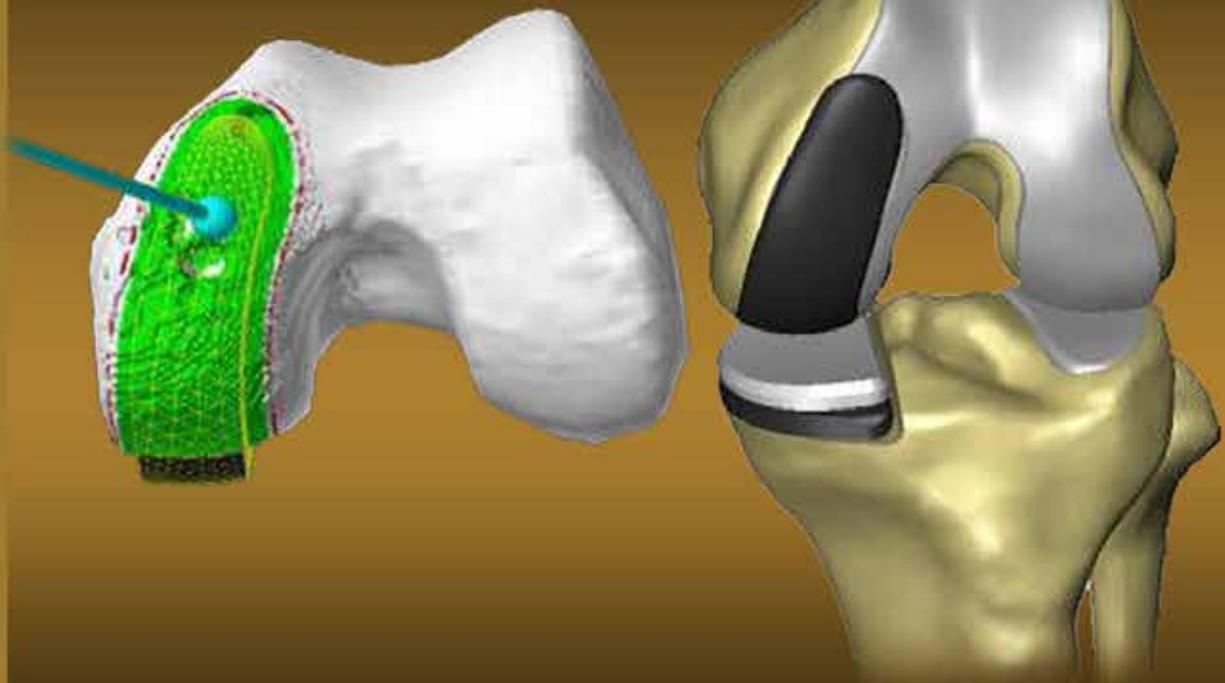


# **PARTIAL KNEE REPLACEMENT: EVERYTHING YOU NEED TO KNOW TO MAKE THE RIGHT TREATMENT DECISION**

- UNDERSTANDING KNEE ARTHRITIS
- MEDIAL UNICOMPARTMENTAL
- PATELLOFEMORAL UNICOMPARTMENTAL
- HOW TO PREPARE FOR SURGERY
- POSTOPERATIVE REHABILITATION AND HOME EXERCISES



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WRITTEN BY AN INTERNATIONALLY RECOGNIZED ORTHOPAEDIC SURGEON  
AND A CLINICAL RESEARCHER WITH DECADES OF EXPERIENCE IN  
TREATING PATIENTS WITH KNEE PROBLEMS

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## About the Authors

Dr. Frank Noyes is an internationally recognized orthopaedic surgeon and researcher who has specialized in the treatment of knee injuries and disorders for nearly 4 decades. He is the founder and chairman of the Cincinnati Sports Medicine and Orthopaedic Center and its nonprofit research foundation. Dr. Noyes completed his orthopaedic training at the University of Michigan Medical Center. He then received a 4-year clinical and research appointment as an orthopaedic surgeon in the United States Air Force, was commissioned as a Lieutenant Colonel, and began his landmark research into knee ligament injuries, the effects of immobilization, biomechanics of ligaments, prevention of ACL injuries in the female athlete, the diagnosis of many knee injuries and problems, and the results of treatment for a variety of knee disorders. Along with Dr. Edward Grood, Dr. Noyes established one of the first biomechanics laboratories in the United States at the University of Cincinnati College of Engineering. The laboratory was subsequently named in his honor as the Noyes Tissue Engineering and Biomechanics Laboratory.

Dr. Noyes has won every conceivable award for his clinical and laboratory research from societies such as the American Academy of Orthopaedic Surgeons, the American Orthopaedic Society of Sports Medicine, the Orthopaedic Research and Education Foundation, as well as the University of Cincinnati. He was inducted into the American Orthopaedic Society for Sports Medicine's Hall of Fame in 2008. Dr. Noyes has been selected by his peers as one of the Best Doctors in America every year since 1992.

Dr. Noyes has published over 260 research studies and textbook chapters on many different types of knee injuries and disorders. He edited a textbook entitled, "Noyes' Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes" which was written for orthopaedic surgeons, physical therapists, and other sports medicine health care professionals. Dr. Noyes is also a co-editor of "ACL Injuries in the Female Athlete. Causes, Impacts, and Conditioning Programs", a textbook written for sports medicine health care professionals, coaches, and trainers involved with female athletes.

Sue Barber-Westin has directed clinical research studies for Dr. Noyes' research Foundation for nearly 3 decades. In the mid 1980's, she authored one of the first studies that measured problems during single-leg hopping tests in patients with ACL injuries, "Quantitative Assessment of Functional Limitations in Normal and Anterior Cruciate Ligament-Deficient Knees." She has co-authored 140 articles in medical journals and textbooks, focusing on the clinical outcome of various knee operative procedures, the methods used to determine the results of clinical investigations, differences in neuromuscular indices between male and female athletes, effects of neuromuscular training in female athletes, and prevention of ACL injuries in female athletes. Sue is the associate editor of "Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes" and the co-editor of "ACL Injuries in the Female Athlete. Causes, Impacts, and Conditioning Programs". Sue has personally undergone 4 knee operations and played competitive junior and collegiate tennis.

In 2004, Sue and Dr. Noyes were members of the research team that won the Clinical Research Award from the Orthopaedic Research and Education Foundation. They are frequently invited to speak at national and international conferences and review articles for orthopaedic and sports medicine journals. Noyes and Barber-Westin have written other eBooks for patients:

- ACL Injury: Everything You Need to Know to Make the Right Treatment Decision
- ACL Injury Rehabilitation: Everything You Need to Know to Restore Knee Function and Return to Activity
- Knee Meniscus (Cartilage) Tears: Everything You Need to Know to Make the Right Treatment Decision

- Patellar (Kneecap) Pain and Problems: Everything You Need to Know to Make the Right Treatment Decision
- Operations for Knee Arthritis: What To Do When All Else Has Failed To Stop Your Knee Pain
- Knee Arthrofibrosis: Everything You Need to Know to Recognize, Treat, and Prevent Loss of Knee Motion After Injury or Surgery

## Introduction

Arthritis of the knee is a potentially devastating condition that affects millions of individuals and costs billions of dollars to treat in the United States alone. In general, knee arthritis involves the breakdown or degeneration of the joint lining (articular cartilage) on the ends of the bones in the knee joint and loss of the normal amount of space between these bones. This results in pain, swelling, and spur formation. When arthritis becomes severe and there is no relief from symptoms and limitations with daily activities, surgery becomes necessary.

The knee joint consists of 3 major compartments: the medial tibiofemoral, lateral tibiofemoral, and patellofemoral. These compartments represent the areas where 2 bones meet and include all of the surrounding soft tissues in that portion of the knee.

Partial knee replacement (also called unicompartmental knee replacement) is an operation where just one compartment of the joint is replaced, instead of all 3 compartments that is done in a total knee replacement (TKR, also called total knee arthroplasty). In order to be considered for this operation, the other 2 compartments in the knee joint should have little or no arthritis and a normal amount of joint space. Only the damaged compartment is replaced with metal and plastic; the rest of the healthy bone and surrounding tissue is left alone.

There have been reports of partial knee replacement that involve replacing 2 compartments in cases where the third compartment is normal. However, very limited data has been published and no long-term studies have been conducted to date on bicompartamental operations. In addition, little information exists in the medical literature on lateral tibiofemoral unicompartmental procedures. This eBook focuses on the more extensively studied unicompartmental procedures performed in the medial tibiofemoral and patellofemoral compartments.

Unicompartmental knee replacement is indicated for patients 30-50 years of age (although it can be done in younger or older patients). These patients have pain with daily activities and often have had prior operations that failed to alleviate their symptoms and problems with knee function. The overall goal of the operation is to buy time before a TKR may be required.

This operation may be thought of as knee “resurfacing” because only the surfaces of the bones are removed and replaced. This is similar to the manner in which a dentist fills a tooth cavity. At our center, the operation is done with the assistance of a robot and advanced software technology that helps the surgeon make very precise calculations and bone cuts in order to achieve the best implant fit possible.

There are several advantages of a unicompartment knee replacement compared to a TKR. The incision is smaller than that required in a TKR and less blood is lost during the operation. The magnitude of the operation and rehabilitation are reduced, the rate of complications is lower, and the knee “feels” more natural since only a portion is replaced. Patients typically only stay in the hospital for one night and are able to return to daily activities within a few weeks.

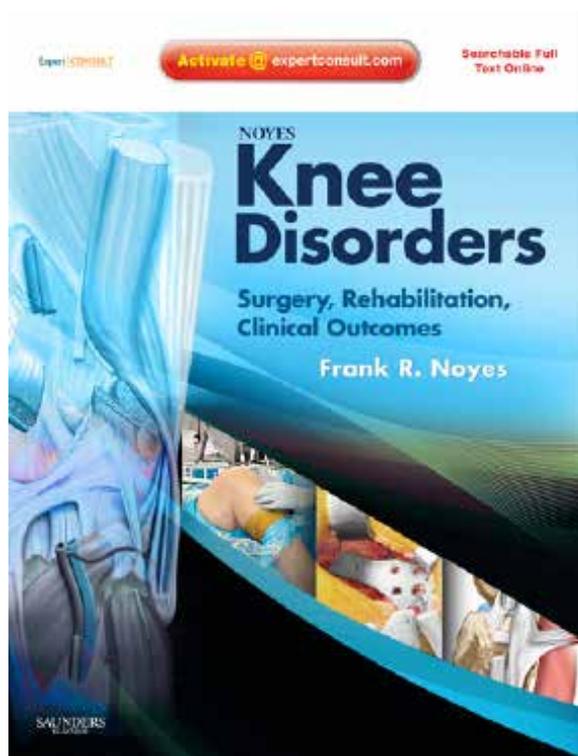
For patients who are greater than 40 years of age, this operation has better and more predictable results than an osteotomy, which is an alignment procedure of the tibia or femur. Finally, it is fairly straightforward for a surgeon to “convert” a partial knee replacement to a TKR if necessary in the future.

Currently, no eBooks exist that provide detailed information on partial knee replacements. After treating patients for nearly 4 decades with knee problems, we decided to write this eBook to try to help individuals under-

stand unicompartmental operations and what to realistically expect as a result of these procedures.

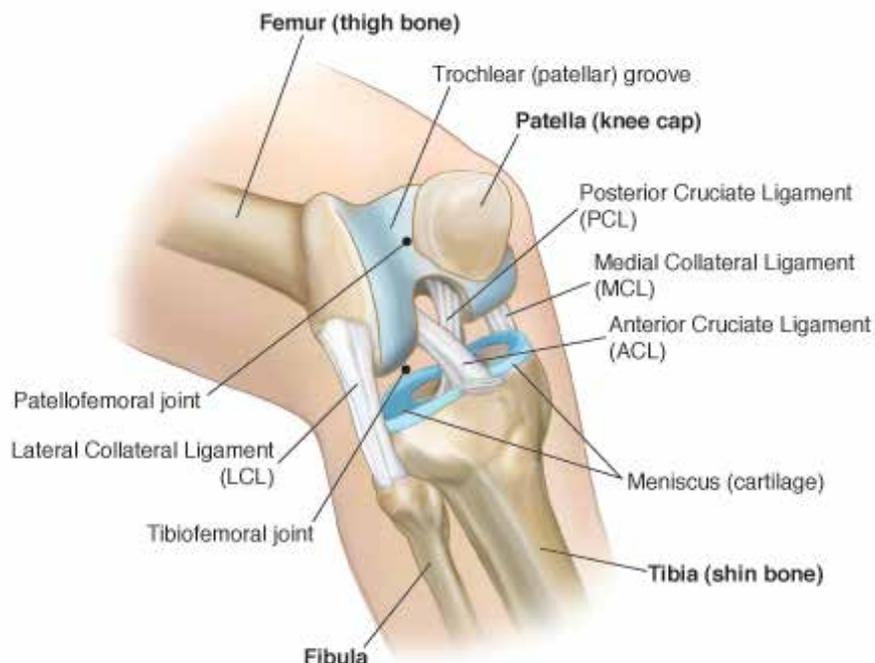
This eBook provides information on basic knee anatomy, the process of arthritis in the knee, the factors that go into deciding whether or not to have a partial knee replacement, what to expect from surgery, and physical therapy required after surgery. In addition, exercises to do at home and in a fitness club are described in detail.

This eBook should not be used for self-diagnosis and treatment of knee arthritis. Only a qualified orthopedist or sports medicine-trained physician can make a definitive diagnosis of this problem. For medical professionals, we recommend our textbook “Noyes’ Knee Disorders. Surgery, Rehabilitation, Clinical Outcomes” for more comprehensive information regarding the diagnosis and treatment of knee arthritis, as well as other knee problems such as knee ligament tears, patellofemoral problems, preventing knee ligament injuries in the female athlete, meniscus injuries, and cartilage restoration procedures.

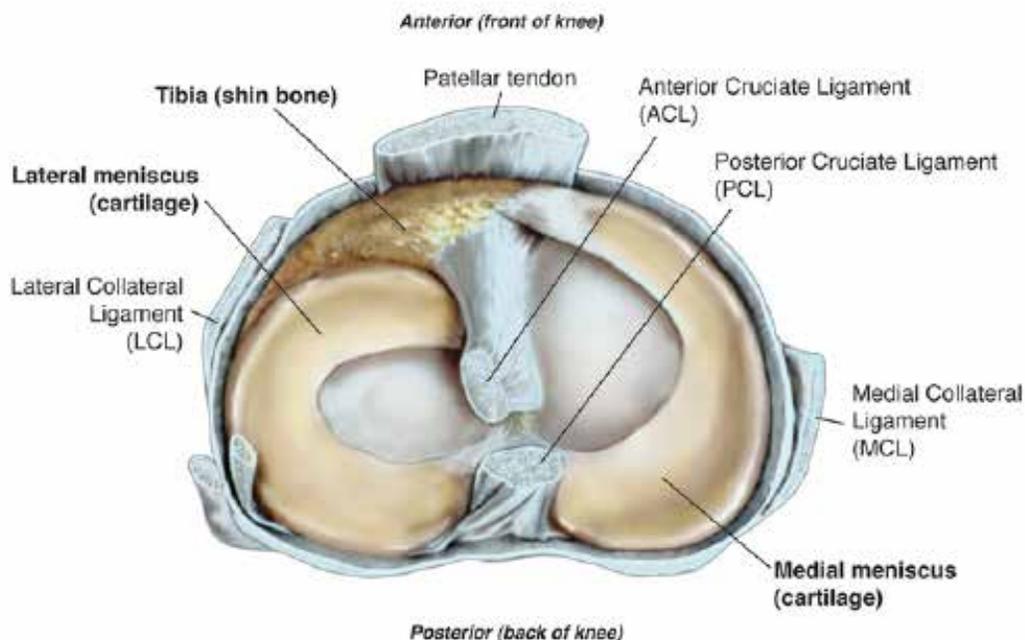


## Basic Knee Anatomy

The knee is a hinge joint. It is made up of 4 bones that are held together by ligaments, tendons, and muscles. The femur (or thigh bone) is the large bone in the thigh. The tibia (or shin bone) is the large bone in the lower leg and the fibula is the smaller bone in the lower leg that lies parallel to the tibia. The patella (or knee cap) is the small bone in the front of the knee that glides up and down as the knee bends and straightens. It is located in front of the femur and glides through a groove called the trochlear (or patellar) groove.



There are 2 types of cartilage in the knee joint: the meniscus (fibrocartilage) and articular cartilage (hyaline cartilage). The meniscus is a C-shaped structure that is located between the weight-bearing ends of the femur (femoral condyle) and tibia (tibial plateau). There are 2 menisci in each knee, the medial meniscus (located on the inner side) and the lateral meniscus (located on the outer side). The menisci are located on the top of the tibia. You may have heard someone say they “tore their cartilage”, which usually means they have torn their meniscus.



Articular cartilage is a smooth protective lining or layer of tissue that is located on the ends of bones where they meet in the knee. In the knee joint, articular cartilage is located on the end of the femur, the top of the tibia, and on the undersurface of the kneecap. This type of cartilage allows the bones to glide smoothly and the knee to flex and straighten easily. The term arthritis basically refers to the breakdown or damage to articular cartilage.

There are 2 joints, or articulations, in the knee. The tibiofemoral joint is the area where the femur and tibia meet. The patellofemoral joint is the portion of the knee where the patella and femur meet.

There are 3 compartments in the knee. These compartments represent the areas where 2 bones meet and include all of the surrounding soft tissues in that portion of the knee. These are the medial tibiofemoral compartment (where the femur and tibia meet on the inside portion of the knee), the lateral tibiofemoral compartment (where the femur and tibia meet on the outside portion of the knee), and the patellofemoral compartment (where the patella and femur meet in front of the knee).

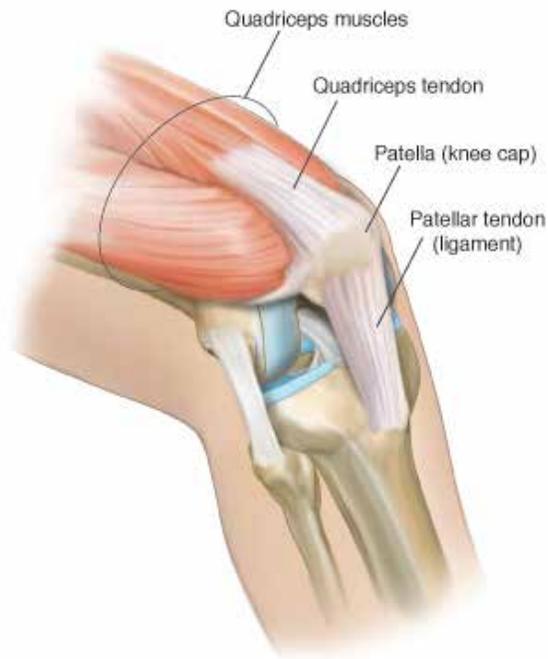
Ligaments connect bones and help provide stability to joints. There are 4 main ligaments in the knee. The anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) cross each other in the center of the knee. They each connect the femur to the tibia. The medial collateral ligament (MCL) is located on the medial (or inner) side of the knee and it also connects the femur to the tibia. The lateral collateral ligament (LCL) is located on the lateral (or outer) side of the knee and it connects the femur to the fibula.

Each ligament has a main job in helping to keep the knee stable when we walk, run, go up and down stairs, kneel, and do any weight bearing activity. In addition, the muscles and other soft tissues in the knee joint help provide stability.

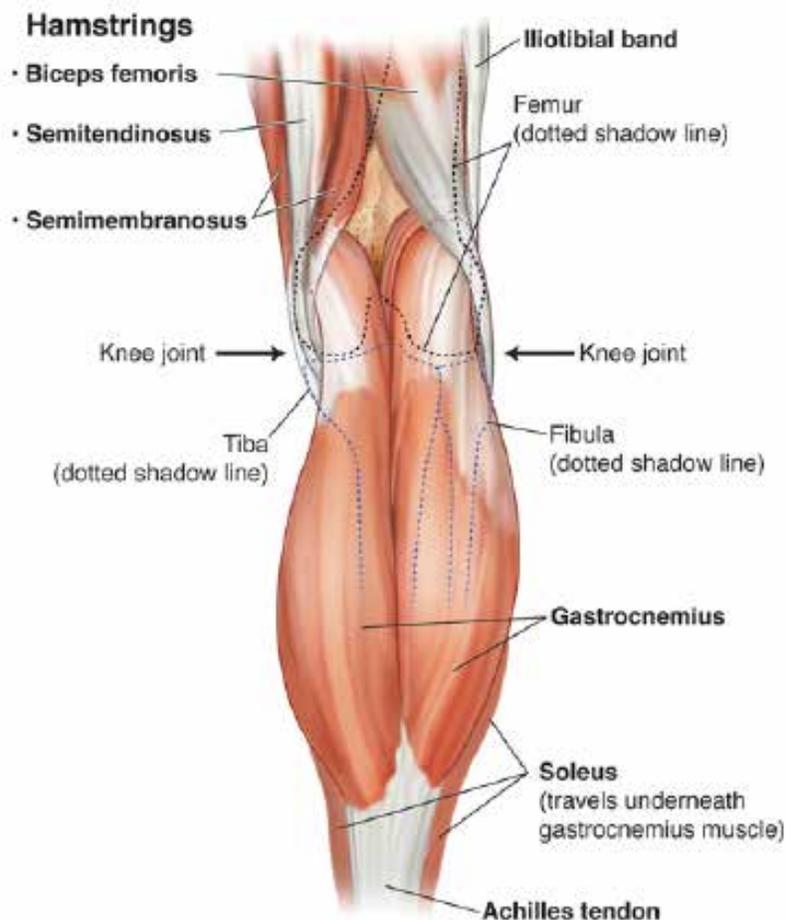
The ACL prevents the tibia from excessive forward motion (called anterior tibial translation) and too much inward twisting or rotation (called internal tibial rotation). The PCL keeps the tibia from moving too far backward. The MCL and LCL act to control the knee's sideways stability and rotation. The popliteofibular ligament, popliteus tendon and muscles also work with the LCL on the lateral side of the knee. These structures are known as the posterolateral complex. They help block knee hyperextension, or keep the knee from bending too far backwards.

There are smaller ligaments that also exist in the knee, such as the meniscotibial ligament that attaches the edges of the menisci to the top of the tibia. The transverse ligament connects the lateral meniscus to the medial meniscus. The medial patellofemoral ligament attaches the inner edge of the patella to the medial portion of the femur. The popliteofibular ligament and fabellofibular ligament connect the femur to the top of the fibula.

There are other important structures in the knee you may have heard of, such as tendons that connect muscles to bone. The quadriceps tendon connects the quadriceps muscles (the large muscles that are in front of the thigh) to the kneecap. The patellar tendon (also called the patellar ligament) connects the quadriceps muscle and kneecap to the upper part of the tibia to bend and extend the knee joint. The hamstrings muscles at the back of the thigh attach to the tibia at the back of the knee via the semitendinosus, gracilis, and biceps tendons.



The muscles that are involved with bending and straightening the knee and also in helping to provide stability to the knee are the quadriceps and hamstrings. The quadriceps are 4 muscles that are located in the front and sides of the thigh (called the rectus femoris, vastus lateralis, vastus intermedius, vastus medialis). They help straighten the knee. The hamstrings are the muscles at the back of the upper leg (called the biceps femoris, semitendinosus, gracilis, semimembranosus) that flex or bend the knee.



Other muscles are also important in providing stability during walking, running, and the like. These include the muscles in the hip (gluteus maximus, gluteus medius, piriformis, adductor muscles) and in the calf (gastrocnemius and soleus).

The iliotibial band is a large band of thick tissue located on the outside of the thigh. It extends from the hip to the knee. This structure also helps to stabilize the knee joint during activities such as running.

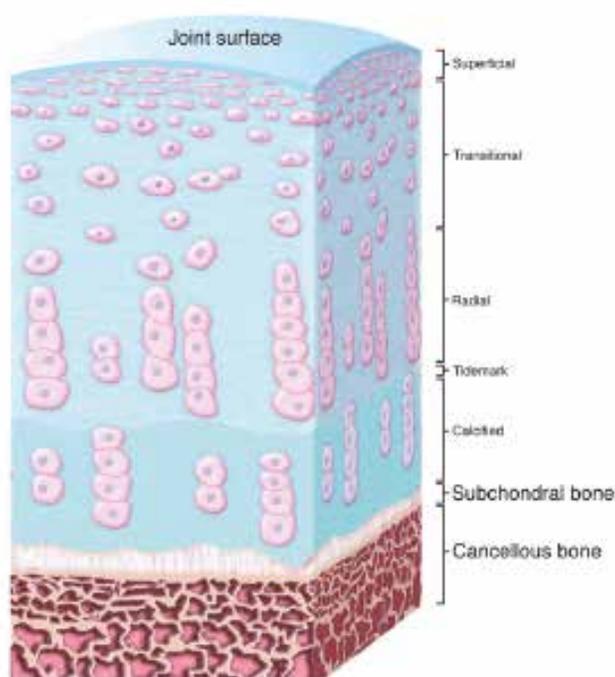
## What Does Knee Arthritis Mean Exactly?

### The Demise of Articular Cartilage

Arthritis in the knee joint refers to the breakdown, degeneration, and eventual loss of articular cartilage that is frequently accompanied with damage to the underlying bone. Over time, there is a loss of the normal amount of space between the bones in the knee joint - including between the end of the femur (femoral condyle) and the top of the tibia (tibial plateau) and between the patella and portion of the femur known as the trochlear groove. With a loss of the cartilage lining, increased pressures are placed on the underlying supporting bone that responds by becoming thicker and harder (this process is called sclerosis). Bone spurs may develop at the periphery (ends) of the joint. Arthritis may occur in just one area of the knee, or throughout the entire joint. It is important for you to understand what articular cartilage is and its importance in the knee joint in order to understand the arthritis process.

Articular cartilage, often referred to as the “joint lining”, is a tissue that is found on the ends of bones in joints that move freely such as knees, hips, wrists, and shoulders. It provides a resilient and compressible surface, or one that is able to recover its shape (called compliance) after being stressed or compressed. Articular cartilage protects the knee joint by distributing loads that are applied during weight bearing activities, thereby limiting the amount of stress that is absorbed by the underlying subchondral and cancellous bone. There are other structures in the knee joint and leg that also have a role in increasing or decreasing lower limb forces and stresses, such as the menisci, ligaments, and muscles.

Articular cartilage is made up of water (70%), type II collagen (about 15%), proteoglycans (about 15%), and chondrocytes (about 1%). Chondrocytes are cells that are responsible for the production of the cartilage matrix, which consists of collagen and proteoglycans. The structure of articular cartilage is described in medical textbooks as a series of zones, each of which varies according to the alignment, number, size, and shape of chondrocytes. These zones are called the superficial (tangential), transitional (middle), radial (deep), and calcified. The calcified cartilage zone contains what is termed the tidemark, a line that indicates the boundary between noncalcified and calcified cartilage. Just under this area is subchondral bone, with cancellous bone located underneath.



Cancellous bone contains red bone marrow where the production of stem cells occurs. Stem cells are responsible for replacing cells in the body that have been damaged or have died. The bone marrow contains hematopoietic stem cells that create blood cells (red, white, and platelets) and stromal stem cells that create bone cells (osteoblasts), cartilage cells (chondrocytes), fat cells (adipocytes), and connective tissue.

Articular cartilage does not contain nerves and has no real ability to repair or restore itself when injured. This is because there are relatively few cells in the tissue, the metabolic rate is low, and the ability of chondrocytes to form new cartilage matrix is greatly limited. When injury to cartilage occurs, the cells increase in number and provide greater matrix components. However, the native original cartilage is not regenerated.

In osteoarthritis, articular cartilage deteriorates as a result of increased water content, reduced number of chondrocytes, reduced concentration of proteoglycan, and a breakdown of the matrix. Even if the body attempts to repair damaged articular cartilage, it usually fails because the repair tissue does not have the same biomechanical properties and structure of normal cartilage. Inflammatory diseases or infection can cause degeneration of articular cartilage.

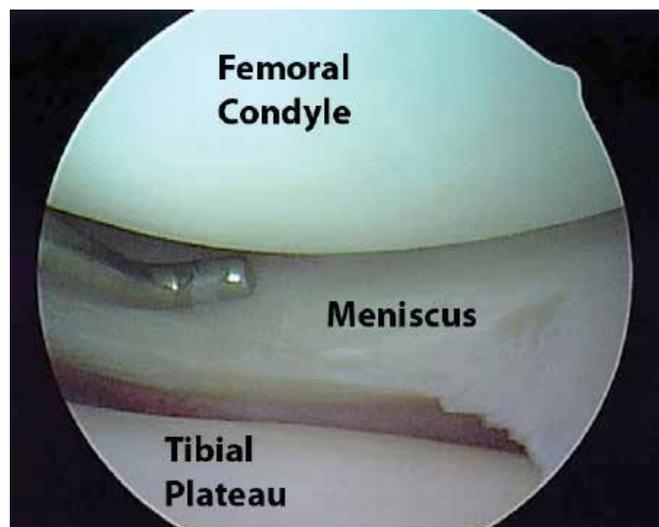
### **Types of Knee Arthritis**

There are many types of arthritis that may affect joints, the most common being osteoarthritis, post-traumatic arthritis, and rheumatoid. Rheumatoid arthritis is an autoimmune disorder whereby the body's immune system mistakenly attacks healthy tissue in joints and organs. It leads to chronic inflammation and may destroy the cartilage in many different joints in the body. It may begin at any age and usually occurs in both knees, along with the wrists, fingers, feet, and ankles.

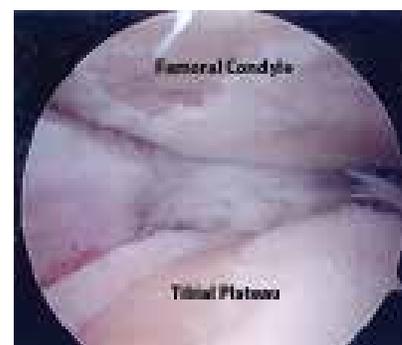
Osteoarthritis is the most common form of knee arthritis. It is a slow, progressive disease in which the knee joint degenerates as the articular cartilage wears away. The underlying subchondral bone may become damaged. There is also a loss of the normal amount of space in the tibiofemoral compartments and/or the patellofemoral compartment. This is what is usually found in middle-aged and elderly patients. It is also referred to as degenerative joint disease, or wear-and-tear arthritis.

Post-traumatic arthritis occurs after an injury to the knee, such as a fracture or tear to a ligament or meniscus. It is similar to osteoarthritis in that it involves loss of articular cartilage. However, this is more frequently found in younger patients, especially those involved in athletics. Partial knee replacement is performed for patients suffering from either osteoarthritis or post-traumatic arthritis.

To the right is a photograph taken at arthroscopy of a normal knee, without any arthritic damage.



Now, take a look at what severe damage to the articular cartilage and joint surface looks like.



## The Knee Examination

### History and Physical Examination

The physician will first take a thorough history to find out when your knee symptoms began or if you ever had a knee injury. You will be asked about what specific problems you are having such as pain, swelling, and instability (giving-way). These are all common symptoms of arthritis.

If you did not have an injury, but your knee just started to hurt, it is important to determine what activities cause your symptoms to start, what makes your problems worse, and what helps relieve them. You will be asked if going up and down stairs, kneeling, squatting, walking long distances, or playing sports aggravate your knee problems. If you had an injury, questions will be asked about when it occurred, what exactly happened, and if you have had more than one injury.

You will also be asked if you have had knee surgery in the past. If this is the case, it is very helpful if you can obtain a copy of the operative note and any photographs that were taken during the operation. Have these on hand for your current physician to review during your appointment.

Pain in the knee may come from different problems. Therefore, your physician should perform many clinical examination tests and techniques while you are standing, sitting, and lying down.

The physician will palpate, or feel, various areas on and around your entire knee joint. This will be done while you are sitting with your leg relaxed, and then with your knee bending and straightening. The physician is trying to determine exactly where your knee hurts. Sometimes, the pain is in a specific location and in other cases, it occurs in many different places or just “all over” (called diffuse pain).

To give you an idea of what the physician is feeling, some of the structures include the medial and lateral retinaculum (soft tissues on both sides of the knee cap), the fat pad, the iliotibial band, the medial patellofemoral ligament, the patellar tendon, the medial and lateral menisci (joint lines), the quadriceps tendon, the insertions of these tendons, the insertions of the vastus medialis oblique and vastus lateralis oblique muscles, the tibial insertion of the patellar tendon, and the saphenous nerve. Your physician will check to see if you have any swelling in your soft tissues or a neuroma present. A neuroma is a small “knot” of nerve tissue or endings that can be painful.



Physician feeling around the kneecap for areas of pain

Your physician should measure the amount of motion in both of your knees, or how much they bend and extend. This is referred to as range of knee motion. When the knee is straight, that is referred to as 0 degrees. When the knee is fully flexed, it usually goes to about 135-140 degrees, although this varies between individuals. Many patients with knee arthritis have a loss of the normal amount of motion in their knee joint. Of particular concern is when the knee cannot reach full extension (become fully straight) that results in limping.

Your physician will also see if you have what is called crepitus, or cracking, in your patellofemoral and tibiofemoral compartments. Your physician will place their hand directly on your kneecap and ask you to bend and straighten your knee through its full range of motion several times over the exam table. Pressure will be applied to see if this causes pain. Crepitus usually indicates some damage to the articular cartilage, but may also be due to impingement of the anterior fat pad, the synovial plica, or from an inflamed synovium.

Your physician will determine how your kneecap moves, or tracks, within the trochlear groove as you bend and straighten your knee. He or she will determine if the soft tissues that help keep your kneecap in place are damaged or not working properly. Tests will be done to see if your kneecap moves too far to the right or left, or can be tilted abnormally.

Sometimes, the kneecap may not move hardly at all due to thickening in the tissues that surround it, which can cause problems. You will be asked to extend (straighten) your knee and then make a hard quadriceps muscle to determine how far your kneecap moves laterally (toward the outside of your leg). This is to determine what is called dynamic quadriceps muscle balance and is done in both legs at the same time.

### **Lower Limb Alignment**

Your physician will determine if your overall lower limb alignment is normal or in a valgus (knock-kneed) or varus (bow-legged) position. This will be done while you are standing and walking.



The position of your kneecap and your feet will also be assessed while you are standing and walking. Your physician will note if your legs move in the same manner when you walk, or if the knee that is hurting moves differently than the other or causes you to limp.

### **Ligaments and Menisci**

If you have experienced an injury or have instability, your physician should examine the meniscus (medial and lateral) and ligaments in your knee to make sure these structures are not injured. A ligament or meniscus tear may be a source of instability. The ligaments examined are the anterior cruciate, posterior cruciate, medial collateral, and lateral collateral. There are specific tests for each ligament that the physician will do if a tear or problem is suspected because of a previous injury.

### **Muscle Strength and Function**

The function, strength, and flexibility of your leg and hip muscles will be determined. These muscles include the quadriceps, hamstrings, gastrocnemius, soleus, hip flexors and extensors, and hip abductor and adductors. Sometimes, using simple hop tests in place will determine if problems in the function of your muscles exist. Your physician will look for muscle atrophy in your thigh and calf, indicated by a decrease in size of the muscle and your ability to tighten the muscle.

### **Imaging Studies (X-rays, MRI)**

There are several different types of x-rays that should be taken of your knees, called anteroposterior, weight bearing 45-degree posteroanterior (Rosenberg) lateral, and axial (Merchant). Some of the x-rays will be taken while you are standing and others, while you are sitting or lying down.

These images help determine the amount of joint space that exists in your patellofemoral and tibiofemoral compartments. In order to be a candidate for a partial knee replacement, the normal amount of joint space is lost in just one compartment of the knee (for instance, the medial tibiofemoral compartment). The other compartments should have a normal or nearly normal amount of joint space, with no more than 50% joint narrowing. The x-ray below shows a knee that is a good candidate for a medial unicompartamental knee replacement. There is a loss of joint space between the medial femoral condyle and medial tibial plateau. However, there is a normal amount of space on the other side of the knee, between the lateral femoral condyle and lateral tibial plateau.



Below are x-rays of a patient who is not a candidate for a partial knee replacement, but a total knee replacement because the arthritic damage is present throughout the knee joint.



In some patients, such as those with bowed legs or knock-knees, other x-rays may be required to precisely measure the alignment of the entire lower limb - from the hip to the ankle. If the varus (bowed legs) or valgus (knock-knees) is more than 3 degrees, then partial knee replacement may not be indicated. However, often the bowed leg is due to loss of the cartilage and can be corrected at surgery by the implant.

We obtain a MRI on all patients who are considering partial knee replacement. This is a common test that shows all parts of the knee, including the ligaments, menisci, and other soft tissues that cannot be seen on an x-rays. MRI is a noninvasive test that does not use any harmful rays and may be done in either a partially closed or open scanner. We order sophisticated MRI images that show the cartilage lining. These are technically known as fast-recovery fast spin-echo images that are obtained using a cartilage-sensitive pulse sequence that allows for high-contrast resolution between articular cartilage, subchondral bone, and joint fluid. These images allow the thickness, size, and location of articular cartilage lesions to be determined.

We obtain a dexta scan on all women before surgery to measure their bone density. An abnormal decrease in bone density is a contraindication for a partial knee replacement operation. Bone mineral density should be +1.0 or higher. The T score should be between +1 and -1. Any value below these indicates osteopenia or even osteoporosis and the weak bone may not support the partial replacement.

## **Conservative Treatment: What You Should Have Already Tried**

### **A Few Comments**

While this eBook focuses on partial knee replacement for severe knee arthritis, we will briefly outline our recommendations for conservative treatment of this problem. If you have not already gone through a course of such treatment, we strongly recommend considering this approach first before undergoing surgery.

Our conservative treatment approach is basically designed for “wear and tear” arthritis of varying degrees and

consists of lifestyle changes (weight control or loss, avoidance of activities that can aggravate the knee), medications (from over-the-counter to prescription anti-inflammatory to injections), physical therapy, and supplements.

We try to use the least amount of medication possible. In many cases of mild to moderate arthritis, the use of occasional over-the-counter pain and anti-inflammatory medications, along with modification of activities and weight loss, is often effective in controlling pain and swelling. The proper precautions regarding the use of various medications should be discussed with your physician. There are risks with taking nonsteroidal anti-inflammatory medications (NSAIDs), including those related to gastrointestinal (nausea, bleeding, ulcers) and cardiovascular (stroke, heart attack) problems. These risks only occur in a small amount of patients, but it is still important that you are informed. Consult with your physician before taking any pain medication, especially if you are already on other medication for problems such as high blood pressure or cholesterol.

### **Weight Control**

Understand that for every pound of weight loss, there is 4-6 pounds of reduced pressure on the knee. Our recommendations for weight control are:

- Decrease size of portions.
- Decrease fat intake. Substitute for red meat, avoid saturated fats, substitute oils for polyunsaturated types (olive, canola, peanut).
- Increase vegetable and fruit intake.
- Learn to count calories.
- Avoid unhealthy snacks and sweets.
- Use meal supplements (Slim Fast, Ensure).
- Seek counseling if required.
- Try a low carbohydrate diet.

### **Aggravating Activities**

The following are considered aggravating activities to the arthritic knee joint that has moderate to severe damage and should be avoided as much as possible. The goal is to limit any activity that produces pain or swelling during or up to 24 hours after the activity. If there is no pain or swelling, then the activity listed is probably safe.

- Standing longer than 30-60 minutes at a time.
- Sitting in one position longer than 30 minutes at a time; includes excessive driving.
- Walking longer than 69-90 minutes at a time without resting or elevating the leg.
- Stairs, inclines/declines.
- Kneeling/squatting.
- Lifting.
- Machine operation.
- Twisting/turning.
- Sports.

### **Mild Arthritis Pain**

Patients with mild arthritis pain are encouraged to lose weight (if they are overweight) or maintain their current weight if they are within the normal range, avoid aggravating activities, decrease high- or moderate-im-

pact sports activities by 50%, and participate in low-impact aerobic exercise. They may occasionally use over-the-counter pain and anti-inflammatory medications such as Tylenol, Aleve, or Advil as needed.

Physical therapy is encouraged to help patients remain active and maintain normal motion in their knee. Flexibility and strengthening exercises to maintain joint mobility are important and may be performed at home daily. This is one of the benefits of having a physical therapy evaluation so that a specific exercise, strength, and flexibility program may be prescribed. All knee-related exercises and fitness machines are low-impact to the knee joint.

The supplement glucosamine-chondroitin sulfate is used by many patients; however, this may only help one in three individuals. If used, try the supplement alone if possible for 4 weeks, then determine if you have experienced a benefit. This supplement may decrease pain but have not been shown to rebuild damaged joint cartilage. Ice is used for knee swelling and after exercise.

### **Moderate Arthritis Pain**

Patients with moderate arthritis pain are encouraged to lose weight (if they are overweight) or maintain their current weight if they are within the normal range, avoid aggravating activities, decrease sports activities by 50-75%, and participate in low-impact aerobic exercise. They may require prescription anti-inflammatory medications intermittently, depending on physician guidelines.

Recurrent knee pain and joint swelling may indicate the consideration of a knee injection using either a steroid or synthetic lubricant such as Synvisc. A knee injection is only recommended when anti-inflammatory medications, diet, and avoidance of aggravating activities are no longer effective. This treatment usually results in good relief of knee pain and swelling in three out of four patients for many months because the medication, 90% of which remains in the knee joint, decreases the inflammation in the knee better than oral medications.

Physical therapy is encouraged to help patients remain active and maintain normal motion in their knee. Flexibility and strengthening exercises to maintain joint mobility are important and may be performed at home daily. This is one of the benefits of having a physical therapy evaluation so that a specific exercise, strength, and flexibility program may be prescribed. All knee-related exercises and fitness machines are low-impact to the knee joint. The supplement glucosamine-chondroitin sulfate is used by many patients; however, this may only help one in three individuals. If used, try the supplement alone if possible for 4 weeks, then determine if you have experienced a benefit. This supplement may decrease pain but have not been shown to rebuild damaged joint cartilage. A knee brace may be helpful. Ice is used for knee swelling and after exercise.

### **Severe Arthritis Pain**

Patients with severe arthritis pain are encouraged to lose weight (if they are overweight) or maintain their current weight if they are within the normal range, avoid aggravating activities, decrease sports activities by 75% or completely, and participate in low-impact aerobic exercise. They may require ambulatory aids such as a cane for assistance. A knee brace may be helpful. They may need to consider changing their occupation if it involves aggravating activities to the knee joint. They may also need to permanently change their participation in recreation and sports.

Prescription anti-inflammatory medications may be used intermittently for symptoms. In general, oral steroids are avoided or only used briefly for severe symptoms. Narcotics are not used in our clinic because they become addictive. Recurrent knee pain may indicate the consideration of a knee injection using either a steroid

or synthetic lubricant such as Synvisc. Physical therapy is encouraged to help these patients remain active and maintain normal motion in their knee. Flexibility and strengthening exercises to maintain joint mobility are important and may be performed at home daily. This is one of the benefits of having a physical therapy evaluation so that a specific exercise, strength, and flexibility program may be prescribed.

### **Choosing an Orthopaedic Surgeon in the U.S.**

Although you may not have a hard time finding an orthopaedic surgeon in your community, finding one who can perform a unicompartmental knee replacement may be difficult.

We recommend that you see a board-certified and fellowship-trained orthopedist for any serious knee operation. The training of an orthopaedic surgeon takes many years of undergraduate college, medical school, and residency education. Most surgeons finish residency training around the age of 30. Then, some choose 1-2 years of additional education known as a sports medicine or joint replacement fellowship in order to receive still more training in order to diagnose complex injuries and perform modern operations.

Orthopaedic surgeons may elect to become “board certified”. This means they must pass rigorous examinations above and beyond those required in medical school and residency. This certification is optional in the United States. Board certified surgeons actively participate in education and stay up to date with the latest advances in medicine and patient care.

Seeing a board certified and fellowship-trained orthopedist is especially important if you decide to have partial knee replacement surgery, because this is not an operation for a physician who has not had specialized, advanced training. The success of this operation is based on 2 things: the ability of the surgeon to do the operation correctly and the ability of the physical therapy program to restore the best knee function possible. It really is a 50-50 process, with both of these issues sharing an equal role in the overall success or failure of the operation to get you back to activities.

The American Orthopaedic Society for Sports Medicine has a list of orthopaedic surgeons at <http://www.sportsmed.org>. As you can see from this society’s website, “Members must demonstrate continuing active research and educational activities in the field of sports medicine. Such activities may include service as a team physician at any level of competition, educating persons involved with the health of athletes, service to local, regional, national and international competitions, and the presentation of scientific research papers at sports medicine meetings.”

The Knee Society is a group of orthopaedic surgeons (sponsored by the American Academy of Orthopaedic Surgeons) who specialize in the treatment of arthritis of the knee joint. The society has an online international Physician Locator section for patients searching for a surgeon who is a member of this society. See <http://www.kneesociety.org/members/directory/search.aspx?directory=public>.

If you live in a large city with a major university or sports medicine center, that is one place to search for a board certified, fellowship trained orthopaedic surgeon. As well, you may know someone who underwent major knee surgery and had a successful result and seeing his or her surgeon is certainly a good place to start.

It might help to consider “interviewing” a potential surgeon before you decide on who will perform your partial knee replacement operation. Some questions to ask are:

How many partial knee replacement have you done in your career, and about how many do you do each year?

Do you keep track of the results of your patients who undergo partial knee replacement?

Where will my physical therapy be done? Who will my therapist be, and how long have you worked with the therapist? (Most surgeons have a few physical therapists they know and trust to work with patients who undergo major knee surgery. What you do not want is for the surgeon to leave finding a therapist in your hands!)

Do you or my therapist have a list of exercises that I will need to do after surgery? Will I see my therapist before the operation to learn about the exercises? Will I be doing exercises at home? How often?

Can I talk to someone in your insurance department about my coverage, both for the operation and physical therapy visits?

How soon will I see you and my therapist after surgery? (We recommend 24-48 hours to make sure your muscles are working properly, the incision looks good with no signs of infection, and you understand the exercises you should be doing.)

## **Medial and Patellofemoral Unicompartmental Knee Replacement Operations**

### **Indications**

Unicompartmental knee replacement is indicated for patients 30-50 years of age (although it can be done in younger or older patients) who have one compartment that has significant damage to the articular cartilage (loss of all cartilage down to bone) and loss of most or all of the joint space in the medial tibiofemoral or patellofemoral compartment. The other compartments in the knee joint should be normal or nearly normal in terms of the condition of the articular cartilage and joint spaces (< 50% joint narrowing). The overall goal of either operation is to buy time before a TKR may be required. It is important to understand that if the rest of the knee joint already has some arthritic damage, a TKR will probably be required within 10 years.

Patients who are considering partial knee replacement typically have severe knee pain or stiffness that limits daily activities such as walking, climbing stairs, and getting in and out of chairs. Pain and swelling may occur while resting, either during the day or at night. The knee problems do not improve with rest or medications. In our clinic, these patients failed to receive any benefit from conservative measures including medications, injections, physical therapy, and weight control.

### **Contraindications**

In our clinic, patients scheduled for a partial knee replacement must agree that if more arthritis is found during the operation than previously expected, the surgeon may elect to go ahead and perform a TKR instead of the unicompartmental.

Excessive body weight (body mass index > 31) is a contraindication to partial knee replacement. Lower limb malalignment (varus or valgus greater than 3 degrees) that cannot be corrected at surgery will increase the forces on the unicompartment knee components and increase the risk for loosening or failure of the operation. It is not advisable to perform this operation if the patient cannot fully straighten their knee, even after under-

going a program of physical therapy. Patients with ligament instability, prior infection, or who have diabetes or rheumatoid arthritis are not candidates.

Women with osteopenia (soft bone) are also not candidates. This is why we obtain a dexa scan in all women before surgery. Bone mineral density should be +1.0 or higher. The T score should be between +1 and -1. Any value below these indicates osteopenia or even osteoporosis.

### **How the Operations Are Done**

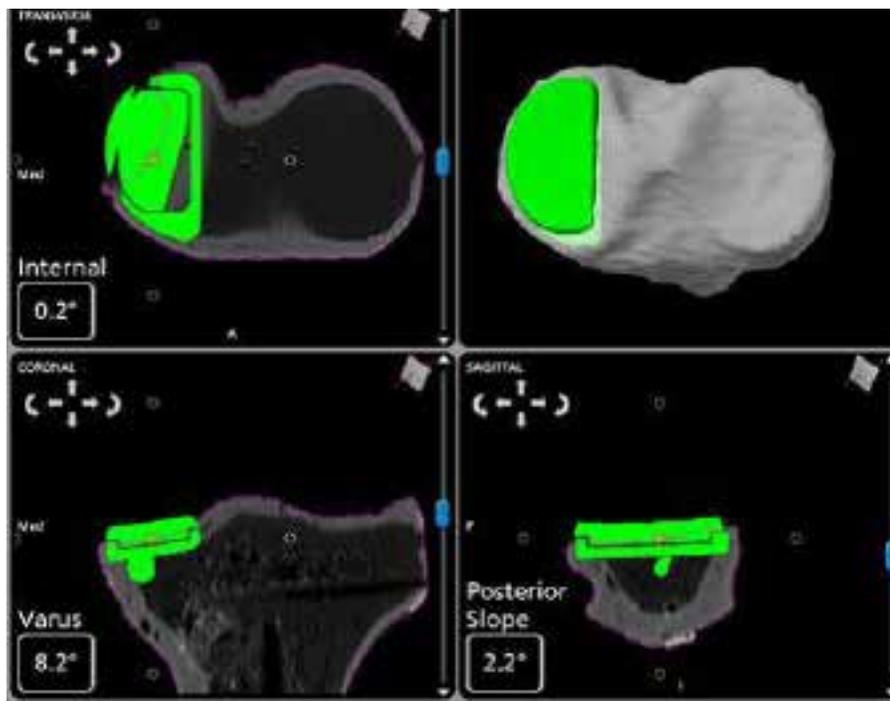
Next, we will describe Dr. Noyes' operative techniques for medial and patellofemoral knee replacements. We use advanced robotic technology to assist in planning and performing these operations, which is quite different from conventional techniques. Please note that there are differences between surgeons in how operations are performed. Talk directly to your surgeon if you have technical questions regarding their own procedures or implants. You should have an understanding of your surgeon's experience with this operation, and if a robotic or conventional technique will be used.

At our clinic, we perform partial knee replacement operations with the assistance of the MAKOplasty (MAKO Surgical Corporation, Ft. Lauderdale, Florida, USA) robotic system. This system uses a highly sophisticated robotic arm (Rio™ Robotic Arm Interactive Orthopedic System) and computer software that enhance the precision of the operation. The robotic system and surgeon work together to make accurate calculations before surgery, resect only the smallest amount of bone required, and place the implant components into the knee in a manner that achieves the best fit possible.

(We declare no conflict of interest, no consultation fees or contracts, and no royalties or ownership of stock in any of the multiple companies that have devices or medical products used for partial knee replacement surgery. Thanks to MAKO Surgical Corporation (Ft. Lauderdale, Florida, USA) for some of the illustrations regarding partial knee replacement surgery.)

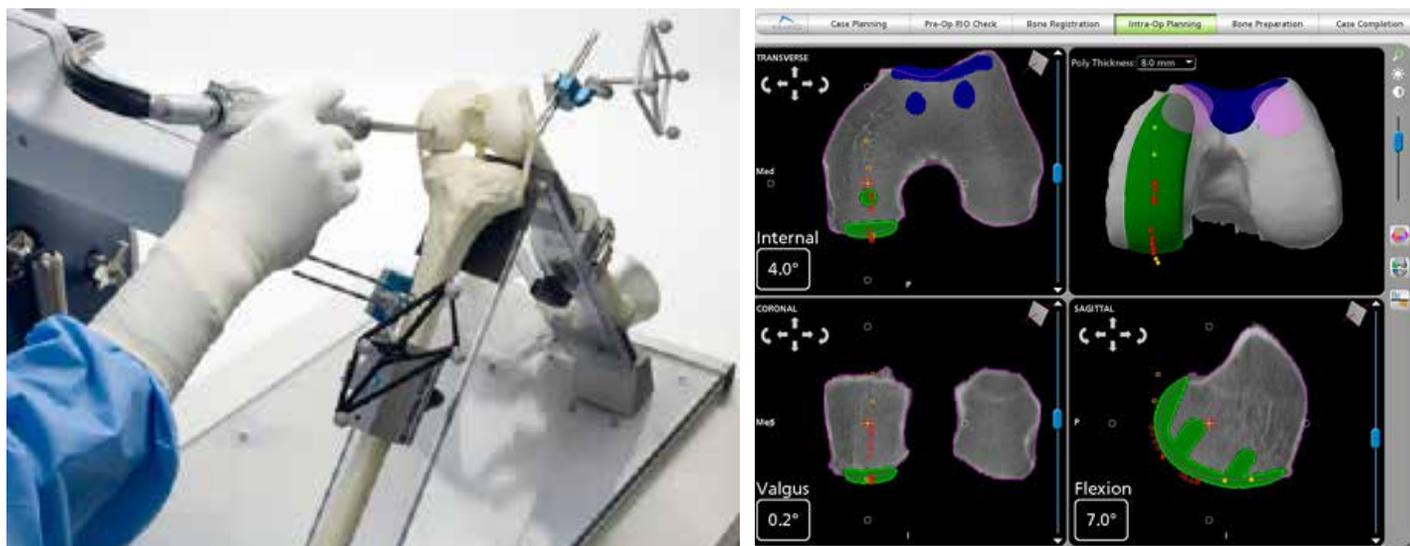


Before the operation, special images are taken of the patient's knee using computed tomography (CT). Several scans are taken of the hip, knee, and ankle joints. The CT scans are fed into a computer and the software program (MAKO Surgical Corp.) creates a 3-dimensional (3-D) model of the patient's knee. This model is used to plan the position of the partial knee implants and areas where bone will be resected. The software sets boundaries for the areas in the knee where bone will be taken out in order to prevent cutting outside these areas. The 3-D model is shown to the surgeon on a computer screen.



Virtual preoperative planning for the bone cuts and implant fit done on a 3-D model, as seen by the surgeon on a computer screen

After the patient has been put to sleep, the incision of approximately 4-6 inches (10-15 cm) is made. Tracking pins are placed into the femur and tibia and a series of bone registration points are collected. These are done in order to set and verify important anatomic landmarks on the tibia and femur.

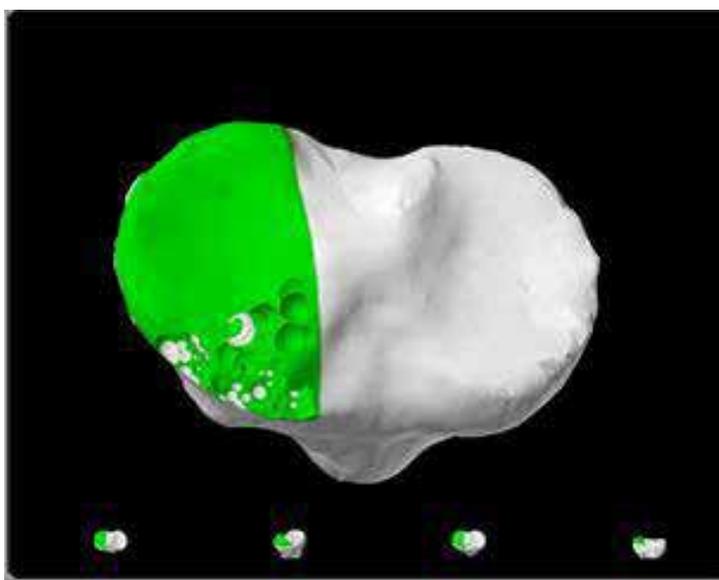


The bone registration process, shown on a knee model (left) and on the computer screen (right).

The resultant registration of the knee anatomy is sent to the computer and is compared to the previously created 3-D model. The goal is to make sure the 3-D model is indeed extremely accurate in representing the patient's anatomy and that the pre-planned implant position is correct. The patient's knee is taken through several cycles of flexion and extension that allows the surgeon to see the position of the simulated position of the implant components as the knee is moved.

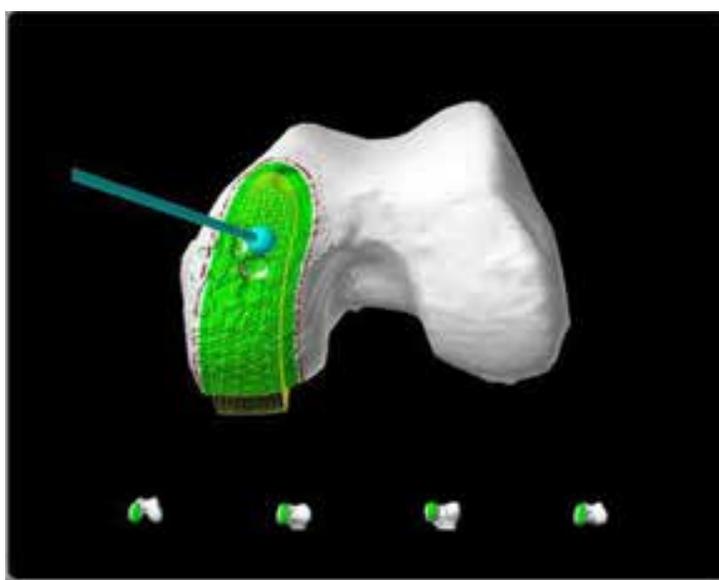
The next step uses the 3-D model and software to plan the balancing of soft tissues. This is an important step to ensure the operation does not over- or under-constrain knee motion (make the knee too tight or loose). The surgeon at this point may fine-tune the position of the components if required.

The next step of the operation involves removing the damaged articular cartilage surfaces and a small amount of bone at either the ends of the tibia and femur (for a medial unicompartmental) or at the undersurface of the patella and trochlea (for a patellofemoral replacement). A burr located at the end of the robotic arm is used by the surgeon to remove the amount of bone according to the boundaries previously set by the software from the 3-D model. As the surgeon removes bone, he or she watches the process on a computer screen.



As the surgeon uses the robotic arm to remove damaged bone, a real-time display of the process is shown on a computer screen.

Top, resection of bone on the top of the tibia.



Bottom, resection of bone on the femoral condyle.

In the medial unicompartmental procedure, the removed cartilage and bone are replaced with metal and polyethylene components that recreate the surface of the joint. In the patellofemoral procedure, the patella is resurfaced with a plastic button and the front of the femur is resurfaced with a chrome cap.

The implants are placed into the knee and images appear on the computer screen, showing the placement and overlapping of the implants as the knee is moved throughout flexion and extension. After the surgeon has accepted the implant position, both of the components are cemented in place. The knee is taken once more through its range of motion. The surgeon verifies the alignment and positioning of the implants.

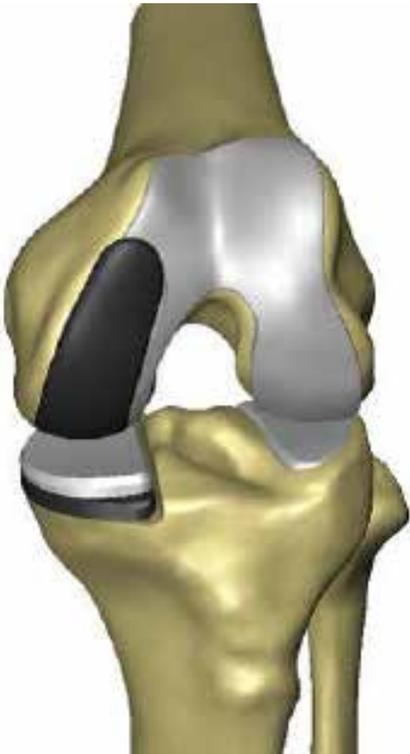


Illustration of a medial unicompartmental knee replacement, with components placed into the knee joint.



X-rays showing the components of a medial unicompartment knee replacement

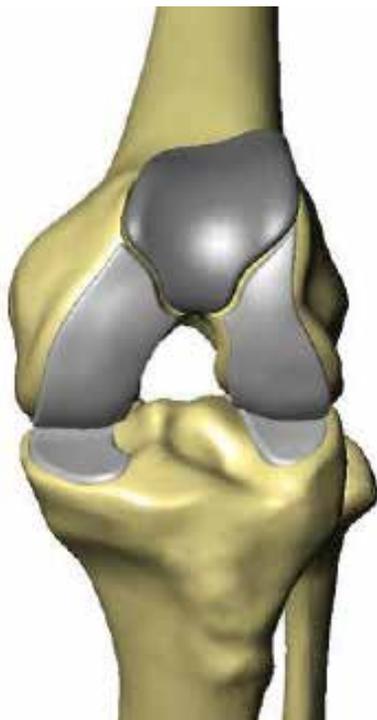


Illustration of a patellofemoral unicompartmental knee replacement, with components placed into the knee joint



X-rays showing the components of a patellofemoral knee replacement

See also <http://noyeskneeinstitute.com/knee-replacement/> for a short video of the operation and a patient who underwent a partial knee replacement.

### **Possible Complications**

The potential complications of partial knee replacement are rare, but include infection, blood clots, implant problems such as loosening or failure requiring revision surgery, neurovascular injury, metal allergy, continued pain, inability to regain knee motion, and other general risks of surgery. You should tell your physician if earrings or finger rings have ever caused the area to become red or inflamed.

Some surgeons recommend after a partial knee replacement that the patient should receive antibiotics the day before and after any future dental procedures, dental cleaning, or operations. This is because there is a rare risk of bacteria in the blood stream “seeding” to the metal implant.

### **Expected Results**

We believe that unicompartmental knee replacement is a viable option for younger patients in whom severe joint damage exists in just one portion of the knee joint. Although early reports of these operations were disappointing, improvements in product materials, design, and robotic technology have changed the expected outcome. It is important that the patient has realistic expectations regarding what this operation may and may not accomplish.

At our Center, most patients are able to walk without a cane or crutches within approximately 2-3 weeks after surgery. The majority can return to their daily activities within 4-6 weeks. Our formal postoperative physical

therapy program lasts for 3 months, but most of the exercises are done at home or a fitness facility. Many of the exercises are shown in detail later in this eBook.

Light, low-impact activities such as walking, swimming, golfing, light hiking, and bicycling can often be performed by 3 months after partial knee replacement. However, running and high-impact athletic or occupational activities are not advised and, in fact, should be avoided. This is because the implant has a limited lifespan (approximately 15-20 years) and high impact forces will shorten this timeframe because they may speed up normal wear and cause the knee replacement to loosen and become painful. With appropriate activity modification and weight control, knee replacements may last for many years.

Studies published within the last 10 years have shown acceptable survival rates (meaning the knee is still doing well) for medial unicompartment knee replacements. High success rates have been reported with the Oxford Partial Knee (Biomet, USA), with survivorship rates ranging from 82% to 96% at 10 years after surgery and from 80% to 91% at 15 years after surgery. Products from Zimmer, Inc. (USA) (Miller-Galante and the Unicompartmental High Flex Knee System) have also very good survivorship rates that range from 80% to 98% at 15 years after surgery.

Studies conducted to date on patellofemoral knee replacement procedures have demonstrated greater variation in long-term survivorship rates. Most short-term (5 years after surgery) survivorship rates are excellent, ranging from 96% to 100% in 6 of 7 studies. Ten-year rates reported in 4 studies ranged from 59% to 90%, and 20-year rates reported in 2 studies dropped to 55% and 69%. The problems in many of these studies were related to patient selection criteria, including use of patellofemoral replacements in patients who had arthritis in other compartments of their knee, advanced age, and high body weight.

We recently conducted a systematic review of studies that reported results of patellofemoral knee replacement in patients who were less than 50 years of age. Five studies were found comprising 193 knees. The prosthetics used in these investigations were Richards type II (Smith and Nephew, Memphis, TN), Custom Performa Knee (Biomet Inc., Warsaw, IN), Custom Patellofemoral Arthroplasty (Kinamed, Camarillo, CA), and Low Contact Stress Patellofemoral Joint (DePuy Orthopedics Inc., Warsaw, IN).

The criteria for failure of these operations were the necessity for either revision of the patellofemoral arthroplasty or conversion to TKA. One study followed 85 patients for an average of 13 years after surgery and found that 24% had failed. Another study followed 45 patients an average of 17 years after surgery and reported that 42% had failed. The other 3 studies followed 59 patients an average of 4.5-6 years after surgery. Only 1 failure was reported and the majority of these patients had no problems with daily activities.

All of the studies mentioned above were conducted before the development of the robotic technology described in this eBook. Articles describing the surgical technique and early results of this advanced technology first appeared in the medical literature in 2009. To date, only a few studies with short-term (1-2 year) follow-up data have been published. Investigations regarding the accuracy and reproducibility of unicompartmental knee replacements have shown the robotic-assisted techniques to be superior to conventional techniques. Whether the improvements in preoperative planning, operative techniques, and implant fit translate into superior clinical outcomes over the long-term have yet to be determined.

### **A Few Comments About Other Operations for Severe Knee Arthritis**

Other than TKA, there are a few other operations that may be done for knee arthritis. These operations include osteochondral autograft transfer, autologous chondrocyte implantation, osteochondral allografting, and oste-

otomy (distal femoral or high tibial). This topic is so large that we devoted an entire eBook to these options, “Operations for Knee Arthritis: What To Do When All Else Has Failed To Stop Your Knee Pain.”

There are specific indications and contraindications for these procedures which are typically done in younger patients. The biggest difference between all of these options and partial knee replacement is that they are done in knees that still have a normal or nearly normal amount of joint space throughout the knee. Osteochondral autograft transfer and autologous chondrocyte implantation are usually done for isolated cartilage defects. Osteochondral allografting is a transplant operation that is rarely done for knees with large areas of cartilage loss. Osteotomy is a realignment procedure for bowed or knock-kneed legs. If you are interested in learning more about these options, we suggest picking up our eBook noted above that is devoted to this topic.

## **Preparing for Surgery**

We realize that differences may exist between what your surgeon might recommend and what we tell our patients in terms of getting ready for surgery. However, we believe that the information we will share with you is valuable and will make your life easier, especially in the first week or two after surgery.

### **Getting Your House Ready**

There are important steps to take to prepare for your surgery. Preparation of your home, purchase of appropriate medications and food, and arranging for assistance for the first week after surgery should all be done well before you go to the hospital. We recommend to our patients that they take the first week off from school or work to stay home and rest. Make the necessary arrangements with teachers, school administrators, or your employer as required.

We ask our patients to have someone in their home assisting them at all times for at least the first week after surgery. We cannot stress how important this is, as for the first few days you will be on strong pain medication and will not be up to doing basic things such as cooking or cleaning. Your doctor and hospital staff will ask you to avoid making any major decisions for the first few days due to the effects of the anesthesia and pain medication.

During the first week after surgery, you should be lying down on a bed or couch with your leg elevated above your heart as often as possible to help control swelling. The only exceptions are when you are doing your exercises or attending to personal bathroom needs. This is a critical time period to control pain and swelling, and the constant elevation of your leg is quite helpful.

Try to arrange your sleeping room on the first floor of your house. If you live in an apartment or residence on another floor, we recommend you plan on staying put in your home for the majority of time the first week after surgery. You will most likely be on crutches, with the amount of time is up to your surgeon's protocol, but we recommend avoiding stairs as much as possible the first week after surgery. A slip or fall could be disastrous for your knee or other parts of your body!

Set up a bed or a foldout couch in either a bedroom or other room on the first floor if possible, and put a good sized table next to it so you can keep medication, ice bags, water bottles, food, etc. right next to you. Place a towel over the table so you won't have to worry about spilling water or food. Also, if there is a couch or recliner with a leg rest on the first floor, make sure there is a table next to it also for your supplies and cover it with a

towel.

Have a good stock of books, magazines, movies, etc. on hand that can keep you occupied while you are resting on the bed or couch. Put fresh batteries in the remote control for your television! Charge up any item you plan on using, such as your music listening device, cell phone, and laptop computer.

If there will be someone living or staying with you the first week, they can get fresh clothes when you need them. If you may have time periods where you will have to be alone, have clean clothes ready close to where you will be spending most of your time. It will be somewhat difficult to put shoes on initially until you regain flexion in your knee. So have slippers, flip-flops, or shoes that you can slip on and off easily readily available.

Hopefully, you have a bathroom on the first floor or close to where you will be sleeping that you can use for at least the first week after surgery. Move all of your supplies into this bathroom, including toothbrush, toothpaste, comb, brush, shaver, shaving cream, soaps, make-up, etc. Make sure you have an ample supply of toilet paper and tissue paper!

You will not be able to drive for a while after surgery. Your surgeon will tell you when you are allowed to drive or operate machinery. The rules we follow are the patient must be off of all prescription pain medications, be able to adequately bend their knee to sit comfortably in the driver's seat, be 50% weight bearing, and be able to produce a good quadriceps contraction. Therefore, arrange for someone to drive you to your postoperative appointments to see your surgeon and physical therapist, and any other places you will need to go, for at least a few weeks after surgery. If you have to take a taxi, know the amount of money you will need and obtain the cash before surgery. Try to avoid public transportation. Even if you are on crutches, the chances of being pushed, shoved, or falling are not worth it, as damage can occur to your knee.

Your surgeon and the office staff will advise you on the preoperative hospital or laboratory tests that will be required, which usually are done within a week before surgery at the facility where your operation will take place. You will also undergo a physical examination. This will involve a thorough history of any medical conditions you have had, any other operations you have undergone, and current medications you are taking. It is quite helpful to bring along a list of all of your medications (include the name of the drug and dose you take) or the actual bottles of drugs. If you have had any operations in the past, write these down along with the dates to make this process easier. The examination will most likely involve a chest x-ray, blood pressure and temperature readings, urinalysis, and blood tests. Other tests may be necessary as required by your physician.

### **Food and Medications**

After surgery, we prescribe 1 aspirin a day for 5 days, a NSAID for at least 5 days (unless contraindicated for stomach or heart disease issues), and pain medication for the first 2-3 weeks. Before the operation, any other medications you routinely take (such as blood pressure or allergy) are discussed to determine when they may be resumed postoperatively.

If, for instance, you normally take aspirin, NSAID, or Advil, you should stop 10 days before surgery. This is to reduce a complication of excessive bleeding during surgery. Also, medications for diabetes (insulin pills) should not be taken the day of surgery.

Well before surgery, make sure you have refilled your routine medications that have been approved by your doctor to be resumed immediately after the operation. You should also purchase whatever medications your surgeon will ask you to take after surgery, including aspirin, anti-inflammatory, and prescription and non-pre-

scription pain drugs. Ask your surgeon what non-prescription pain medication you should take once you are weaned off of the stronger prescription drug. Many patients do not like the “feeling” of prescription pain drugs and try to stop taking them as soon as possible after surgery. You will need to switch to a non-prescription pain medication, such as Tylenol (acetaminophen), Motrin (ibuprofen), or Aleve (naproxen) as determined by your surgeon because the control of pain is of tremendous importance. If your pain is not adequately controlled, you will not be able to do your knee exercises and may have an increased risk of a complication such as muscle atrophy or loss of normal knee motion.

One other item to have on hand from the pharmacy is a laxative. Unfortunately, one side effect of surgery and pain medication is constipation. If you have never taken a laxative before, ask your surgeon for advice. If you already suffer problems with constipation, eat lightly and decrease meats and bulky food 2 days before surgery. We recommend that you eat a yogurt product the week before surgery to lessen the risk of operative antibiotics disturbing normal intestinal flora, causing diarrhea.

In terms of what you will eat and drink after surgery, you will be thirsty the first few days (another side effect of the surgery and pain medication). Plan on having either bottled water or someone who can get you glasses of water as you require. We recommend staying away from carbonated beverages after surgery. Food should be light and easy to digest - avoid heavy sauces, creams, and spices. Try not to consume a lot of sugar and sodium (salt). Reducing your sodium intake may help with the swelling you will have in your knee, or that may develop in your foot/ankle. Make a trip to the grocery store the day before surgery and carefully select items that will be easy on your stomach. You should have someone prepare your meals the first week after surgery. If necessary, you can prepare “comfort food” and freeze it so it can be eaten as you wish. You won’t need (or want) to eat large meals, but you will need to eat some food each time before you take pain medication.

Make sure you have a good supply of gallon-sized plastic bags on hand, or other bags that can be used to hold ice. You will be applying bags of ice to your knee quite frequently. If you do not have a reliable icemaker in your home, purchase a few bags of ice to have on hand for at least the first week after surgery. A bag of frozen vegetables (for example, peas) may substitute for ice bags. A portable ice wrap machine costs approximately \$150-200 and is highly beneficial. The ice wrap dressing is worn continuously and the temperature is controlled. You will need to take your temperature twice a day for about the first week after surgery, so make sure you have a working thermometer.

If you have pets, make sure you have a good supply of food and any other material (such as cat litter) they may require. If you have a dog that needs to be walked daily, find someone to handle this for you until you are off of crutches and can walk comfortably. If you can, pay any bills that are due or will be due the week after surgery. Have some cash on hand.

### **Practice the Exercises You Will Do After Surgery**

If you have not already worked with a physical therapist before your operation, you will need to find one and have a consultation before surgery. Your surgeon should be able to recommend a physical therapist that he or she is familiar with and trusts to handle your important postoperative exercise program. We believe it is vital to have a good and trusting relationship with your therapist and the support staff (physical therapy assistants, athletic trainers, personal trainers), because you will be spending more time with these individuals than with your surgeon after the operation.

All of our patients see a physical therapist and learn the exercises they will perform at home a few days before their surgery. They are provided with a list of the exercises and how many or how long each one should be done

every day. It is extremely important that you begin gentle range of knee motion, ankle pumps, and quadriceps isometrics the day after surgery. Find a place (preferable on the first floor) in your residence where you can do the exercises comfortably and safely.

You will most likely need to use crutches or a cane after your surgery. Your physical therapist should instruct you on the correct way to use them and make sure they fit you properly. Practice using your crutches (including going up and down stairs) so you are comfortable and confident with them before surgery. Take up any small throw rugs in your house, as these can be hazardous when using crutches. Consider purchasing a backpack to use to carry items if you will be on crutches for a few weeks or longer.

### **Mental Preparation**

An important aspect in getting ready for surgery is the development of a positive attitude and willingness to work hard every day for as long as is required to regain normal function in your knee. Getting the most information you can (such as reading this eBook) about surgery and rehabilitation is quite helpful for this process. This is why we make sure our patients meet with their physical therapist before surgery and have a comfort level with the postoperative process. Don't hesitate to ask any question, regardless of how you think it may sound, to your medical team. Fears of the operation and lengthy rehabilitation are to be expected. It is helpful to talk through these feelings with your friends, family members, and medical support staff. A complete understanding of what you are about to go through is extremely useful in developing a positive attitude.

Your medical team should provide you with realistic expectations and goals of the surgery. It is important to also realize that the recovery from surgery may take many months.

There are online message and support boards that can be helpful as you deal with your surgery and recovery, such as KneeGuru.com. Don't hesitate to use these measures for support; however, be cautious and understand that patients recover in different time frames. Always use your own surgeon and physical therapist for decision-making and determination of your progress. Do not become frustrated or lose your motivation because some patients seem to be making better progress than you both before and after surgery.

### **The Night Before Surgery**

Your surgeon will ask you not to eat or drink anything after midnight (or at least 8 hours before surgery). This is called NPO, or nothing by mouth. It includes everything, even water. If you have medication you must and are allowed to take the morning of your operation, it should be done with a very small sip of water. The purpose for NPO is to reduce the risk of vomiting during the operation.

If you have a cough, fever, or open skin sore, call your surgeon's office as this may prevent you from having surgery.

Try to get a good night's sleep! Don't consume excessive food or beverages (especially alcohol). You want to wake up feeling fresh and ready for the day ahead. If you are very anxious about surgery, your doctor can prescribe a mild evening sedative to help you sleep.

It is important to wash your body and the leg to be operated on with antibacterial soap 3-4 days before surgery, the night before, and the morning of surgery. We recommend Hibiclens (chlorhexidine) bottled soap that you may purchase at a pharmacy. This markedly reduces skin bacteria. If you have had a MRSA (methicillin-resistant staphylococcus aureus) or other skin infection, be sure to tell your physician. MRSA is a very potent bacteria

and may reside or colonize in the interior of your nose, which is detected by a preoperative nose culture swab.

## **The Day of Surgery**

Take a shower the morning of surgery before coming to the hospital. As we just discussed, wash the leg to be operated on with Hibiclens. We ask our patients not to shave the leg that will be operated on. The staff at the hospital will take care of shaving the desired area of your knee and leg so you don't accidentally cut yourself, which might prevent the operation from occurring that day. Let your doctor know if you have a tape or Iodine allergy or any antibiotic or medicine allergy.

Leave all of your jewelry at home, as none can be worn to the operating room and the hospital staff cannot be held responsible for any lost items. Bring a pair of loose fitting shorts and a shirt that is easy to pull on. Wear tennis shoes and bring socks. If you were given elastic TED hose stockings, a brace, or crutches, bring these items as well.

If your surgeon has approved any medication to be taken, do so at this time. Use as little water as possible to swallow the medications.

We ask our patients to arrive at the hospital 90 minutes ahead of the estimated starting time of the operation. You should bring something to read or listen to while you wait. Unless you have the very first starting time of the day, be prepared to wait even longer than your designated starting time. Some operations take longer than anticipated, and it is difficult to know in advance exactly when your surgery will begin.

You will eventually be called back to the "preop" area, which is usually located very close to the operating rooms. Here you will be assigned a nurse who will verify your medical history and current medications. The nurse will ask you if you are allergic to any medications.... and this will happen several times with other hospital staff, so don't be surprised. Your nurse will immediately check your blood pressure, temperature, and oxygen saturation of hemoglobin in the blood (with a small pulse oximeter that is attached to your finger). Do not worry if your blood pressure is higher than normal because this is expected if you are nervous about the operation. Your nurse will begin your intravenous line (and attach monitors to allow your vitals to be watched during the operation. These include electrocardiography pads placed on your chest to monitor your heart rhythm, the pulse oximeter, and a blood pressure cuff.

You should have already discussed anesthesia with your surgeon. In addition, the anesthesiologist who will be involved with your operation will meet with you while you are being prepped. The anesthesiologist's goal is to take you smoothly from your normal, awake, relaxed condition - to sleep in the operating room - to an awakened state in the recovery room.

Your anesthesiologist will talk to you about any health problems you may have and their impact on your anesthetic. Feel free to ask any questions at this time. Conditions to be brought to his or her attention include diabetes, heart disease, lung disease, high blood pressure, previous anesthetic complications, or family history of problems with anesthesia. If you are taking any diet medications, please let the anesthesiologist know. A light general anesthesia is commonly used, but there are cases where spinal is recommended. Try not to be afraid of anesthesia, as the hospital staff will follow a specific routine to make this procedure safe and lessen any risks.

In accordance with the Joint Commission on the Accreditation of Healthcare Organizations, we follow the Universal Protocol in order to avoid operating on the wrong knee. In fact, since 2004 in the U.S., preoperative

surgical site marking has been mandatory in hospitals and surgical centers. Our patients designate the knee to be operated on by writing their initials on the thigh (just above the knee) with a marker. The surgeon confirms the correct knee joint and marks his or her initials on the same thigh area. Finally, before the operation begins, a “time-out” is taken at which point all of the surgical personnel repeat the identification of the patient, the correct leg to be operated on, the procedure that will be done, and verify any allergies that exist or special precautions that apply to the patient. Within two hours, you will receive a dose of antibiotics through the IV as a precaution for postoperative infection. This may be repeated at the end of the operation.

Once you are taken into the operating room, you will move from the transfer bed to the operating room table. Some operating rooms are cold, so be prepared and don't hesitate to ask for a blanket! Soon, medication will be placed into your IV to put you to sleep. A tube may be placed in your throat while you are asleep as part of the anesthesia process.

When the operation is finished, the medicines that kept you asleep are discontinued and you will wake up in the recovery room. Do not be surprised if your vision is blurry or if your throat is a little sore. A nurse will be with you as you wake up and will ask if you have any pain or nausea. Anesthesia has come a long way and very few patients experience nausea or vomiting after their surgery. Surgeons administer pain medication at the end of the operation, which is called preemptive pain management. The nurse will ask you several times over the next hour or so if you are in any discomfort. On occasion, a femoral nerve block into the groin is performed if pain becomes a problem.

You will have elastic stocking on your non-operated leg. A large bulky compression dressing will be on your operated leg. Depending on your surgeon's protocol, you may also have a knee immobilizer or brace over the dressing. In some instances, you will be able to go home the same day. In some cases where pain or nausea is a problem, the surgeon may decide you should stay overnight at the hospital.

Remember, it is normal to be scared or apprehensive about the surgery and hospital experience. Keep in mind that the hospital staff - nurses, anesthesiologist, and operative team - are all very experienced and will try to keep you as comfortable as possible during the entire process. It is exceedingly rare for a problem to occur, but if something does happen, you should be reassured that the medical professionals will be able to address the issue.

## **Recovering From Surgery**

### **Prevention of Blood Clots in the Legs (Deep Venous Thrombosis)**

The risk of blood clots in the legs (called deep venous thrombosis), or embolism in the lungs from a clot, is usually low after surgery. If you are overweight, have heart disease, diabetes, or history of blood clots or phlebitis, your risk for this complication is increased. In these cases, you will be placed on a blood thinner medication. Talk to your doctor if you or a member of your family has ever had phlebitis or a blood clot problem.

To lessen the risk of blood clots, we recommend that you walk around the house (using crutches, cane, or a walker for support) 6-8 times a day, for about 10 minutes at a time, starting the day of surgery. Take 1-2 aspirin a day (depending on body mass) for 5 days unless you are allergic to aspirin or you have a stomach ulcer or stomach bleeding condition. Use the TED hose stockings to maintain good blood flow. Do ankle pumps for 5 minutes every hour you are awake to increase circulation. Leave the compression dressing on until your post-operative appointment.

Importantly, call your surgeon's office if you develop any calf or leg pain or swelling that is not alleviated by medication and cold therapy.

If you have experienced phlebitis or a blood clot previously, medication will be prescribed to thin your blood after the operation. In addition, if any members of your family have had blood clots, you will likely undergo screening tests to make sure you do not have an inherited gene disorder that may cause an increase in blood clotting.

For women taking oral contraceptives, be sure and talk with your surgeon to determine if you should stop the medication before surgery. Oral contraceptives may increase the risk of blood clots.

If you are prescribed Coumadin (Warfarin), remember not to eat spinach or green leafy vegetables that act to increase the effect of the medication.

### **Our Postoperative Physical Therapy Program**

Next we will summarize our postoperative physical therapy program. We provide guidelines on what exercises to do according to "phases" of the rehabilitation program. Goals are listed that should be achieved before going from one phase to another. Therefore, while we provide an estimate of the weeks post-injury or post-surgery in which the phases occur, it is important that the goals have been reached and your knee is not having problems with excessive swelling, pain, or instability.

Our patients begin exercises the day after surgery, many of which are done at home. In addition, other exercises and machines are used in the physical therapy clinic. We strongly believe that you should see your surgeon and physical therapist within 48 hours of the operation. During this visit, your wound will be checked to make sure there is no excessive swelling, redness, calf pain, or other problem. Your medical team can determine if your quadriceps muscle has "turned on" and that you can make a muscle and lift your leg off of the exam table. They can also make sure you are doing the initial exercises correctly, including your range of knee motion and patellar mobilization. We strongly disagree with letting you wait a week or more before seeing your surgeon and therapist. Knee surgery is not something to be taken lightly and there are potential complications that may happen. Making sure you are on the right track from the very beginning is important and helpful to your overall recovery.

Instructions for the exercises are provided in the Home Exercises; Health, Fitness Club Exercise Machines; and Pool Training sections. Follow the number of repetitions shown in these instructions. The first time you exercise on machines (such as a stationary bicycle or leg press), have a physical therapist or trainer make sure it is adjusted correctly according to your body dimensions. The therapist or trainer should also help to determine the amount of weight to start with initially and make sure you perform the exercise correctly.

The exercises and machines (called modalities) used during your physical therapy appointments will vary according to what is available at the facility where you will complete your program and your therapist's knowledge. We provide examples of some of the exercises and machines used at our center.

Our formal program lasts for approximately 3 months. At that time, if the patient has progressed as expected, they are released and encouraged to continue their strengthening and cardiovascular program as they desire. They return 6 months later for a check-up, and then yearly with the orthopaedic surgeon.

## Phase 1: Weeks 1-2

### *General Comments:*

The important goals the first week after surgery are to control pain and swelling. We recommend that you take the week off of work or school to rest. Stay in bed or on a couch as much as possible with your knee elevated above your heart.

Our patients receive a portable ice compression machine that they use at home for cold therapy. If you do not have such a device, fill 2 gallon-size plastic bags with ice. Place 1 bag on top of your knee and 1 bag underneath your knee (with the brace off, if you have one) for 20 minutes 4-6 times a day. Do not put the bags directly on your skin or incision(s).

Take your temperature twice a day, once in the morning and once in the evening. Call your surgeon's office if your temperature rises above 101 degrees or if you develop chills or feel feverish.

It is very important to keep your incision(s) clean and dry and away from any material that could cause an infection. Keep your incision(s) away from anything that might transmit bacteria. Do not soak your knee in a bathtub, hot tub, or pool until you receive permission from your surgeon or therapist.

We allow our patients to take a shower 2 days after surgery, but they must wrap their leg in plastic to protect the incisions. It is a good idea to place a stool in the shower so you can sit down and prevent a slip, twist, or fall. If you feel weak and unstable, or do not have a stool to put in the shower, wait another day or two. Have someone wash your hair in the kitchen sink and take sponge baths.

Our patient use crutches for approximately 2-3 weeks with partial weight bearing allowed. Crutches are discontinued as the patient resumes a normal gait pattern.

### *Home Exercises (perform each exercise as indicated):*

- Ankle pumps, 5 minutes every hour you are awake
- Quadriceps isometrics (full extension), 10 repetitions, 3 x/day
- Range of knee motion (passive, 0-110°), 6 x/day
- Patellar mobilization, 6 x/day
- Straight leg raises (all), 3 x/day
- Knee extension, active-assisted (range as tolerated), 3 x/day
- Hamstring stretch, 6 x/day
- Calf stretch, 6 x/day

### *Exercise Machines:*

Cardiovascular (2 x/day for 10 minutes):

- Upper body cycle

### *Exercises, Modalities in Physical Therapy:*

- Weight shifting
- Passive-active joint repositioning
- Balance board, 2-legged
- Cup walking
- Single leg stance
- Electrical muscle stimulation, biofeedback (for quadriceps muscle)

- Electrical muscle stimulation, cryotherapy (for pain, swelling)

*Goals:*

- Range of knee motion: 0-110°
- Adequate quadriceps contraction
- Control joint inflammation, effusion
- Weight bearing with crutches or walker used for balance if required

**Phase 2: Weeks 3-4**

*General Comments:*

During this time period, the crutches are gradually discontinued. It is very important to control knee joint pain and swelling and the therapist will want to see you show good quadriceps muscle and leg control while you are doing your exercises.

*Home Exercises (perform each exercise 3 times a day):*

- Quadriceps isometrics (multi-angle)
- Range of knee motion (passive, 0-135°)
- Hanging weights if you do not have 0° of extension, 6-8 x/day
- Rolling stool or wall slides if you do not have 90° of flexion, 6-8 x/day
- Patellar mobilization
- Straight leg raises (hip flexion, hip extension, hip adduction)
- Hamstring curls, active (0-90°)
- Knee extension, active (90-0°)
- Hamstring stretch
- Calf stretch

*Exercise Machines:*

Cardiovascular (2 x/day for 10 minutes):

- Upper body cycle
- Stationary bicycling (high seat, low resistance)

*Exercises, Modalities in Physical Therapy:*

- Weight shifting on ground or on force platform
- Ankle pumps (plantar flexion with resistance band)
- Passive-active joint repositioning
- Balance board (2-legged)
- Cup walking
- Single-leg stance
- Electrical muscle stimulation, biofeedback (for quadriceps muscle)
- Electrical muscle stimulation, cryotherapy (for pain, swelling)

*Goals:*

- Range of knee motion: 0-135°
- Control joint inflammation, effusion
- Full weight bearing
- Reminder: use ice for 20 minutes at a time as needed for swelling

### Phase 3: Weeks 5-6

#### *General Comments:*

During this time period, you will normally place all of your weight on your operative leg while walking. You should have no pain and no or only slight swelling.

#### *Home Exercises (perform each exercise 2-3 times a day):*

- Range of knee motion (passive, 0-135°)
- Hanging weights if you do not have 0° of extension, 6-8 x/day
- Rolling stool or wall slides if you do not have 110° of flexion, 6-8 x/day
- Patellar mobilization
- Straight leg raises (all), with ankle weight
- Hamstring curls, active (0-90°)
- Wall sits (0-45°)
- Toe raises
- Heel raises
- Hamstring stretch
- Calf stretch

#### *Exercise Machines:*

##### Strength:

- Knee extension
- Leg press
- Multi-hip or hip abduction/adduction
- Upper body weight training
- Core training

##### Cardiovascular (1-2 x/day for 10 minutes):

- Stationary bicycle
- Upper body cycle

#### *Pool Training (may do instead of stationary bicycle, 1-2 x/day for 10 minutes):*

Water walking

#### *Exercises, Modalities in Physical Therapy:*

- Cup walking
- Weight shifting on ground or on force platform
- Balance board (2-legged)
- Single-leg stance (level surface)
- Electrical muscle stimulation, biofeedback (for quadriceps muscle)
- Electrical muscle stimulation, cryotherapy (for pain, swelling)

#### *Goals:*

- Range of knee motion: 0-135°
- Good muscle control
- Control joint inflammation, effusion
- Walk normally
- Medical team recognizes and treats any complications (loss of knee motion, pain syndromes, patellofemoral)

problems)

- Reminder: use ice for 20 minutes at a time as needed for swelling

#### **Phase 4: 7-8 Weeks**

##### *General Comments:*

During this time period, you should have no pain or swelling, can walk without pain or limping, and show good muscle control with your exercises. You should have 0-135° of knee motion.

##### *Home Exercises (perform each exercise 2 times a day):*

- Straight leg raises (all), with weight or resistance band
- Mini-squats
- Step-downs: 2-4" block
- Wall sits
- Toe raises
- Heel raises
- Hamstring stretch
- Calf stretch

##### *Exercise Machines:*

###### Strength:

- Leg press
- Multi-hip or hip abduction/adduction
- Knee extension
- Hamstring curls
- Upper body weight training
- Core training

###### Cardiovascular (choose one, 1-2 x/day for 10-15 minutes):

- Upper body cycle
- Stationary bicycle
- Stair machine
- Ski machine
- Elliptical

##### *Pool Training (may do instead of cardiovascular machine, 1-2 x/day for 10-15 minutes):*

- Water walking
- Swimming (straight leg kicking)

##### *Exercises in Physical Therapy:*

- Balance board (1-legged), stable vs. unstable surface
- Single-leg stance (level surface)

##### *Goals:*

- Range of knee motion: 0-135°
- Walk normally
- Control joint inflammation, effusion
- Increase muscle endurance

Reminder: use ice for 20 minutes at a time as needed for swelling

### **Phase 5: 9-12 Weeks**

#### *General Comments:*

You should have no pain or swelling, be able to walk for 30-60 minutes without pain or limping, and have no problems with the exercise program. Your therapist should perform a manual muscle test of your leg and hip muscles, with the goal of scoring a 4+/5.

#### *Home Exercises (perform each exercise 1-2 times a day):*

- Straight leg raises (all), with weights or resistance band
- Mini-squats
- Wall sits
- Lateral step-ups: 2-4" block
- Hamstring stretch
- Calf stretch
- Quadriceps stretch
- Iliotibial band stretch

#### *Exercise Machines:*

##### Strength:

- Leg press
- Multi-hip or hip abduction/adduction
- Knee extension
- Hamstring curls
- Upper body weight training
- Core training

##### Cardiovascular (choose one, 1-2 x/day for 15 minutes):

- Stationary bicycle
- Walking
- Stair machine
- Ski machine
- Elliptical

#### *Pool Training (choose one instead of cardiovascular machine, 1-2 x/day for 15-20 minutes):*

- Water walking
- Swimming (straight leg kicking)

#### *Exercises in Physical Therapy:*

- Balance board (1-legged), stable vs. unstable surface
- Single-leg stance (unstable platform)

#### *Goals:*

- Increase strength and endurance
- Increase balance and coordination
- Range of motion: 0-135°
- Reminder: use ice for 20 minutes at a time as needed for swelling

## Home Exercises

### Ankle Pumps

While lying down with your legs elevated above your heart, pump your ankles up and down continuously.

### Range of Knee Motion

This exercise is performed passively, which means that the muscles in your operated leg are relaxed and your knee is moved either by your therapist, assistant, or with your other leg. To perform this exercise at home, hang your legs over a bed, counter, or chair and use your opposite (non-operated) leg to assist in bending and straightening your knee. Place the foot of the opposite leg in front of the leg of the operated knee and push back for flexion. Place the foot of the opposite leg in back of the foot of the operated knee and pull up for extension. Go back as far as you can for flexion, hold for 5 seconds, then go up as far as you can for extension. Repeat for 10 minutes at a time.



### Patellar Mobilization

You may either have an assistant perform this exercise or use your own hands. Move your kneecap as far as possible to the right, to the left, up (toward your thigh), and down (toward your shin), holding each position for 10 seconds. Perform for 5 minutes after you complete your range of knee motion exercises.



## Hanging Weights

This is an excellent exercise if you are having difficulty getting your knee straight. Sit up in bed, on a couch, or on a table with your back well supported. Prop up your foot and ankle (of your operated knee) on a towel or other item to elevate the lower leg, allowing your knee to drop into extension. Hold this position for 10-15 minutes at a time and perform 6-8 times a day. Add weight (up to 20 pounds) on the lower part of your thigh to provide more pressure if needed.



## Rolling Stool

This is an excellent exercise if you are having difficulty getting your knee to bend. Sit on a small stool with wheels and move forward with your knee flexed to the maximum position possible. Hold that position for approximately 1 minute or as long as you can. Then, roll the stool forward without moving your foot position on the floor to gain a few more degrees of flexion and hold that position for as long as possible. Relax your knee for 2 minutes and repeat. This exercise may also be done using a large physioball. Perform for 10-12 minutes at a time and repeat 6-8 times a day.



## Wall Slides

This is another good exercise if you are having difficulty getting your knee to bend. Lie on your back on a bed or the floor and place the foot of your reconstructed knee on a wall. Place the foot of your opposite leg on top of the foot of the reconstructed knee and use it to gently flex your knee in a gradual manner by sliding down the wall. Then, reverse the position of the feet and slide them back up the wall to the starting position. Perform for 10-12 minutes at a time and repeat 6-8 times a day.



### Quadriceps Isometrics: Full Extension

Sit up in bed, on a couch, or on a table with your back well supported. Keeping your knee as straight as possible, contract or squeeze your thigh muscle and raise your leg off of the bed or couch a few inches. Do not allow your knee to go into hyperextension. Hold for 10 seconds, then lower the leg back down and relax. Repeat 10 times. As you become stronger, see how long you can keep your leg off of the bed or couch. Challenge yourself to hold your leg for 30, 45, 60 seconds and so on. Perform on both legs.



### Quadriceps Isometrics: Multi-Angle

Sit up in bed, on a couch, or on a table with your back well supported. Use pillows placed under your knee to change the angle of the knee joint. The goal is to put the knee at approximately  $90^\circ$  (A),  $60^\circ$  (B), and  $30^\circ$  (C) as shown below. For each joint angle, contract or squeeze your thigh muscle for 10 seconds, then lower the leg back down and relax. Repeat 10 times for each angle. Rest for 1 minute between sets. Perform on both legs.



### **Straight Leg Raise: Hip Flexion**

Lie on your back. Tighten your thigh muscle, keep your knee as straight as possible, and lift your leg straight up off of the bed or floor. Hold for 3 seconds, then lower the leg back to the starting position. Perform 1 set of 10 repetitions, rest for 30 seconds, and repeat the exercise 2 more times for a total of 30 repetitions. Add weight around your ankle as the exercise becomes easy to complete. Perform on both legs.



### **Straight Leg Raise: Hip Extension**

Lie on your stomach. Keeping your knee straight, lift your leg toward the ceiling. Hold for 3 seconds, then lower the leg back to the starting position. Perform 1 set of 10 repetitions, rest for 30 seconds, and repeat the exercise 2 more times for a total of 30 repetitions. Add weight around your ankle as the exercise becomes easy to complete. Perform on both legs.



### **Straight Leg Raise: Hip Abduction**

Lie on your side, the opposite of the leg that is painful. Keeping your knee straight, lift the leg up sideways toward the ceiling. Hold for 3 seconds, then lower the leg back to the starting position. Perform 1 set of 10 repetitions, rest for 30 seconds, and repeat the exercise 2 more times for a total of 30 repetitions. Add weight around your ankle as the exercise becomes easy to complete. Perform on both legs.



### **Straight Leg Raise: Hip Adduction**

Lie on your side, the one that is painful. Bend the opposite leg and place the foot on the ground in front of the other knee as shown below. Lift your leg toward the ceiling, keeping the knee straight and the toes pointed straight ahead. Hold for 3 seconds, then lower the leg back to the starting position. Add weight around your ankle as the exercise becomes easy to complete. Perform on both legs.



## Straight Leg Raises With Resistance Band

In these exercises, you will perform the same motion that is done during straight leg raises, except you are standing with a resistance band or rubber tubing tied around your ankle/lower leg. Secure the other end of the band or tubing around a heavy object. You will change the position of your feet in order to work the hip adductors, abductors, flexors, and extensors as shown in the photographs below.

To help maintain balance, hold onto an object and slightly bend the leg that is not being exercised. Move the foot with the band in the desired direction out as far as possible to ensure the band is tight.

Perform 3-5 sets of 30 repetitions, moving the band as fast as possible. Rest for 1 minute between sets. Perform on both legs.



Hip adduction.  
Starting position (A) and ending position (B)



Hip abduction.  
Starting position (A) and ending position (B)

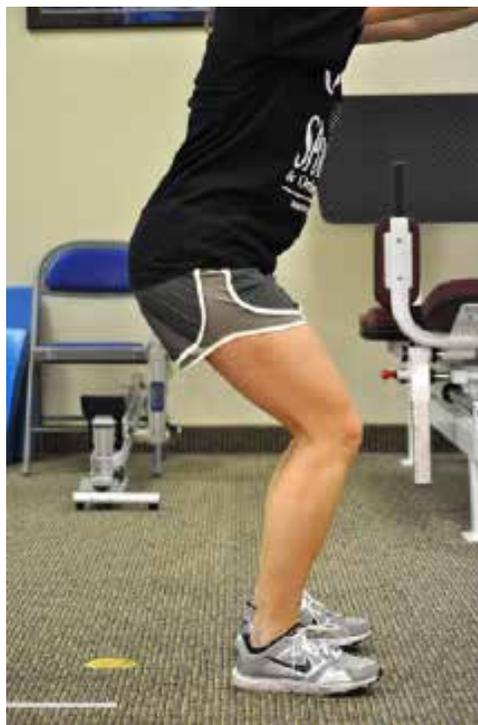


Hip flexion.  
Starting position (A) and ending  
position (B)

Hip extension.  
Starting position (A) and ending  
position (B)

### Mini-squats

From a standing position, squat down to a 45-degree angle. Hold for a few seconds and then slowly rise back up. Perform 3 sets of 20 repetitions each. This exercise may also be done on an unstable surface, such as foam, cushion, or rocker board.



### Hamstring Curls, Active

This exercise may be performed either from a standing position or lying on your stomach. Attach a small ankle weight (with the amount of weight determined by your physical therapist) and bend your knee from 0-90 degrees behind you as shown below. Perform 3 sets of 10 repetitions. Rest for 1 minute between sets. Perform on both legs.



### Knee Extension, Active-Assisted

Sit up with your back well supported. Begin with your knee flexed to 90 degrees. Place the foot of the opposite leg underneath the other heel and use it to lift the leg so your knee comes up to 30 degrees. Then, tighten the thigh muscles of your leg as hard as possible, completely remove the opposite foot, and lower your leg slowly back to the 90-degree starting position. Perform 3 sets of 10 repetitions. Rest for 30 seconds between sets. Perform on both legs. Add ankle weight when able, begin with 5-10 pounds and perform 3 to 5 sets of 10 repetitions.



### Knee Extension, Active

Sit up with your back well supported. Begin with your operated knee flexed to 90 degrees. Using only that leg, lift so the knee comes up to 0 degrees of extension, hold for a few seconds, then slowly lower back to the starting position. Perform 3 sets of 10 repetitions. Rest for 30 seconds between sets. Perform on both legs. Add ankle weight when able, begin with 5-10 pounds and perform 3 to 5 sets of 10 repetitions.

### Wall Sits

Wear gym shoes for this exercise. Stand in front of a wall and place your feet about 2 feet away from the wall. Then, sit against the wall until your knees are flexed to 60-70 degrees. Feel the quadriceps muscles in both legs with your hands, which should feel equal. Wait until you feel a burn in your quadriceps and then hold this position as long as possible to achieve fatigue. Then, carefully stand up, rest for 2-5 minutes, then repeat the exercise. Perform 4 times a day. As you progress, you may place a ball between your knees and squeeze it as hard as possible for the entire exercise. You may also sit a little lower, to 90 degrees if possible, provided no pain is felt in your kneecap or patellar tendon.



### **Toe Raises**

From a standing position, come up onto the toes of your feet, raising your heels completely off of the ground. Hold for 1-2 seconds and then slowly return to the starting position. This may also be done using just one foot (single-leg). Hold onto a stable object for balance and control if necessary. Perform 3 sets of 10 repetitions. Increase repetitions as you are able.

### **Heel Raises**

From a standing position, raise the toes of your feet as high as possible while keeping the heels on the ground. Hold for 1-2 seconds and then slowly return to the starting position. Hold onto a stable object for balance and control if necessary. Perform 3 sets of 10 repetitions. Increase repetitions as you are able.

### **Lateral Step-ups**

Stand next to a step or low platform. Place one foot up on top of the platform. Then, bring your other foot up, lightly tap this foot on the platform and return it back to the starting position. Lower and raise the foot by bending and straightening your knee, maintaining good balance and posture. Repeat 10-15 times and then do the same for the opposite side. You may increase the difficulty of this exercise by holding free weights in your hands. The height of the step or platform should be no more than 12 inches and may be lower if any pain is felt in the kneecap during the exercise.



### **Step-downs, Stable and Unstable Surface**

Begin by standing on a step or low platform. Step down slowly on one leg, then step up backwards leading with the opposite leg. Repeat 10-15 times and then do the same for the opposite side. You may increase the difficulty of this exercise by holding free weights in your hands. The height of the step or platform should be no more than 12 inches and may be lower if any pain is felt in the kneecap during the exercise. This exercise may also be done by stepping onto any unstable surface, including foam, a cushion, or rocker board.

### Hamstrings Stretch

Sit with your leg lying straight in front of you and bend the opposite knee so that the foot is resting against the inner portion of the other thigh as shown below. Keeping your back straight, slowly lean forward until you feel a stretch in your hamstrings. Hold each stretch for 30 seconds and repeat 5 times on each leg.



### Calf Stretch

Sit on a bed or recliner with a foot rest with your back well supported. Take a large towel and roll it up so that is long and thin as shown below. Wrap the middle of the towel around the toes of your leg. While keeping your knee straight, use the towel to bend your toes back toward you until you feel a stretch in your calf muscles. Hold each stretch for 30 seconds and repeat 5 times on each leg.



### Iliotibial Band Stretch

Sit on the floor, bend your right knee, and keep the left knee straight and flat on the floor. Cross the foot of the right side over the left knee as shown below. Place one hand on the floor behind the hips and use the other arm to press the chest toward the knee and foot. This stretch may be done lying on the back to support the spine and neck. Hold each stretch for 30 seconds and repeat 5 times on each leg.



## Quadriceps Stretch

From a standing position, grab a foot or ankle and lift it up behind your body. Gently pull the lower leg and foot up, directly behind the upper leg. Do not twist inward or outward. Hold each stretch for 30 seconds and repeat 5 times on each leg.



## Health, Fitness Club Exercise Machines

Listed below are some simple exercises you may do at a health club to help strengthen the muscles of your legs and hips and improve your cardiac fitness. We strongly believe that you should be under the care of a physical therapist that can guide and progress your exercise program and make sure that the strength training does not cause further knee pain.

Always do the stretches shown in the Home Exercise section last in your exercise sessions. If any of these exercises cause pain in your kneecap, stop immediately.

The first time you exercise on the machines described below, have a physical therapist or trainer make sure the machine is adjusted correctly according to your body dimensions. The therapist or trainer should also help to determine the amount of weight to start with initially.

## Leg Press

Beginning at 70 degrees (A), extend your knees slowly to 10 degrees (B), hold for 1-2 seconds, and slowly return to 70 degrees. Make sure you do this exercise only from 70-10 degrees! Do not press your knees out until they are fully extended, and do not allow your knees to bend all of the way back. Push up through your heels and not your toes. Complete 3 sets of 10 repetitions. Rest for 30 seconds between sets. Gradually increase the amount of weight as you are able.



## Hip Abduction/Adduction

If your fitness facility only has a hip abduction/adduction machine (and not a multi-hip cable machine), then use this to work these muscles. However, if your facility has a multi-hip cable machine, use that instead. On the abduction/adduction machine, be sure to work your legs together, moving gradually and holding the abduction or adduction position for 1-2 seconds before returning to the starting position. Complete 3 sets of 10 repetitions. Rest for 30 seconds between sets. Gradually increase the amount of weight as you are able.

## Multi-Hip

A multi-hip machine allows all of the hip muscles to be exercised, including the hip flexors, extensors, abductors, and adductors. Use good posture (keep your back straight) throughout the exercises and hold onto the support bars to ensure you are working just your hip muscles. Complete 3 sets of 10 repetitions in all 4 directions on both sides. Rest for 30 seconds between sets. Gradually increase the amount of weight as you are able.



## Knee Extension

Beginning at 90 degrees (A), extend slowly to 30 degrees (B), hold for 1-2 seconds, and slowly return to 90 degrees. Make sure you only do this exercise from 90-30 degrees! Do not extend your knees out past 30 degrees, as this will place excessive forces on your kneecap. Complete 3 sets of 10 repetitions. Rest for 30 seconds between sets. Gradually increase the amount of weight as you are able. You may either use both legs to move the bar up and down, use both legs to push the bar up and one leg to bring the bar back down, or use just one leg to move the bar up and down. Perform equal sets on both legs.



## Hamstring Curls

Beginning at 0 degrees (A), flex slowly to 90 degrees (B), hold for 1-2 seconds, and slowly return to 0 degrees. Make sure you do this exercise from 0-90 degrees! Complete 3 sets of 10 repetitions. Rest for 30 seconds between sets. Gradually increase the amount of weight as you are able. You may either use both legs to move the bar down and up, use both legs to push the bar down and one leg to bring the bar back up, or use just one leg to move the bar down and up. Perform equal sets on both legs.



## Upper Body Weight Training

It is important during your rehabilitation to include exercises to strengthen the muscles in your arms, shoulders, chest, and upper back. There are many options available that use either free weights or weight machines. The major upper body muscle groups that should be exercised include the deltoids, pectorals, triceps, biceps, trapezius, rhomboids, and latissimus dorsi. Work with your therapist or a trainer at your fitness facility to develop this aspect of your training program. Your program should be tailored to the sport or activity you wish to return to upon your medical release.

## Core Training

The “core” is the area of your body that includes your pelvis, abdomen, and lower back. Core strength is crucial to maintain postural support and movement of the trunk. Core stability contributes to athletic performance. In fact, poor core strength may cause injury. The muscles in the abdomen and lower back may be strengthened in many different ways, using either weight machines or exercises such as sit-ups, crunches, bicycle kicks, supine bridges, planks, etc. Work with your therapist or a trainer at your fitness facility to develop this aspect of your training program. Your program should be tailored to the sport or activity you wish to return to upon your medical release.

## Stationary Bicycle

A stationary bicycle offers a cardiovascular exercise option that we allow provided it does not cause kneecap pain. It is important to adjust the seat height correctly so that your knee is just slightly bent when the pedal is in the lowest position. We recommend using low resistance and a level setting. If you begin to experience knee-

cap or patellar tendon pain during or after riding the bicycle, stop and talk to your therapist.

### **Cross-Country Ski**

This is an excellent machine to use for cardiovascular fitness because it has very little impact on your knee and it also works muscles in your core and upper body. At first, make sure your stride is short, you use the level setting (no incline), and a low resistance. If you begin to experience kneecap pain during or after using this machine, stop and talk to your therapist.

### **Elliptical**

This is an excellent machine to use for cardiovascular fitness and has the additional benefits of applying very little impact on your knees (and other joints as well) while working the muscles in your core and upper body. At first, make you use the level setting (no incline) and a low resistance. If you begin to experience kneecap or patellar tendon pain during or after using the elliptical, stop and talk to your therapist.

## **Pool Training**

### **Water Walking and Other Basic Aquatic Exercises**

Walk in a pool with the water at least waist-high, forwards and backwards. Gradually increase your speed, the length of your steps, and the distance covered. Make sure you walk with high knee steps, exaggerated from your normal walking appearance. You can also march across the pool. Partial squats and lunges can be done in shallow water in the same manner as they are done on land. There are a variety of exercises that may be done in the pool to increase strength and flexibility, many of which require buoyant or other aquatic equipment. A kick board may be used when walking to increase the amount of resistance. A noodle may be used to support the upper body while doing bicycle kicking. Knee flexion curls may be done with a buoyant circle. Knee extension resistance exercises may be done by placing a noodle under the bottom of a foot and pressing down. In addition, the upper extremity and core muscles may be exercised in a variety of ways in the pool. These including performing arm circles under water, first with the palms up and then with the palms facing down. A buoyant device can be placed between your legs and freestyle swimming done using just your arms. If you have access to a pool and enjoy training in the water, work with your therapist to develop a comprehensive program to be used in conjunction with your other land-based exercises.

### **Swimming (Straight Ahead Kicking)**

If you would like to swim, use only straight ahead kicking, as in freestyle and backstroke. Consider adding a mask and snorkel to make breathing easier. You may also use flippers and perform simple flutter kicking to further strengthen your legs.

## Acronyms and References

ACL, anterior cruciate ligament  
 CT, computed tomography  
 LCL, lateral collateral ligament  
 MCL, medial collateral ligament  
 PCL, posterior cruciate ligament  
 TKA, total knee arthroplasty  
 TKR, total knee replacement  
 3-D, 3-dimensional

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