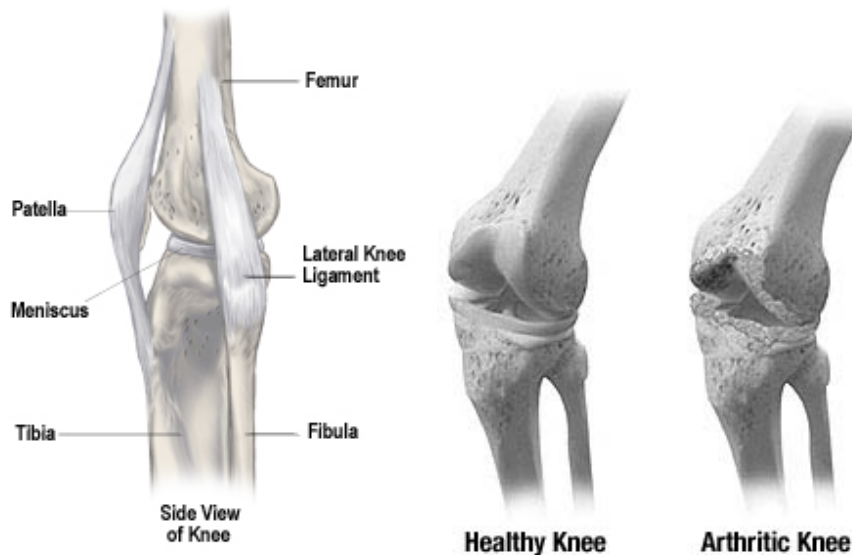


## Knee Anatomy

The knee is the largest joint in the body. A healthy knee moves easily, allowing you to walk, turn, and squat without pain. A complex network of bones, cartilage, ligaments, muscles, and tendons work together to make a knee flexible.

Your knee joint is made up of three bones. Your thigh bone (femur) sits on top of your shin bone (tibia). When you bend or straighten your knee, the rounded end of your thigh bone rolls and glides across the relatively flat upper surface of your shin bone. The third bone is often called the kneecap (patella), which is attached to the muscles that allow you to straighten your knee. Your kneecap provides leverage that reduces strain on these muscles.

Ligaments (another type of soft tissue) lie along the sides and back of the knee, holding the bones of the knee joint in place. These ligaments work with the muscles that control the bones, and the tendons that connect the muscles to the bones, so you can bend and straighten your knee. Fluid-filled sacs (bursae) cushion the area where skin or tendons glide across bone. The knee also has a lining (synovium) that secretes a clear liquid called synovial fluid. This fluid lubricates the joint, further reducing friction and making movement easier.



The decision to have a total knee replacement procedure is up to you and your orthopaedic surgeon. Your doctor will consider a number of factors, including:

- Medical history
- Weight
- Health status
- Anatomical structure, including bone structure and type of arthritis.

### **Symptoms**

Knee replacement is considered when:

- Joint damage is visible on x-ray
- Episodes of pain, swelling, and stiffness in the knee are prevalent
- Persistent pain and disability interfere with daily life activities
- Mobility is extremely limited

Nonsurgical interventions, such as medication, physical therapy, and the help of a cane or other walking aid, are unsuccessful

To diagnose your condition, an orthopaedic surgeon will perform a thorough examination of your knee, analyze x-rays, and conduct physical tests. You will be asked to describe your pain, if you suffer from other joint pain, and if you have endured past injuries that may have affected your current knee condition. Your joints will then be tested for strength and range of motion through a series of activities, which include bending and walking. X-rays of your knee joint will indicate any change in size, shape or unusual circumstances.

Based on your examination, your surgeon will determine whether you are a candidate for the Mini-Incision knee procedure. While total knee replacement is a proven option to alleviate knee arthritis pain, your surgeon may also advise you on non-operative treatment options including anti-inflammatory medications or injections, physical therapy, or a cane to aid in walking.

The final decision to undergo the Mini-Incision TKA procedure is ultimately yours, in consultation with your doctor. As with any surgery, there are risks involved. Some complications during and after surgery can include infections, blood clots, prosthesis loosening, and nerve damage.

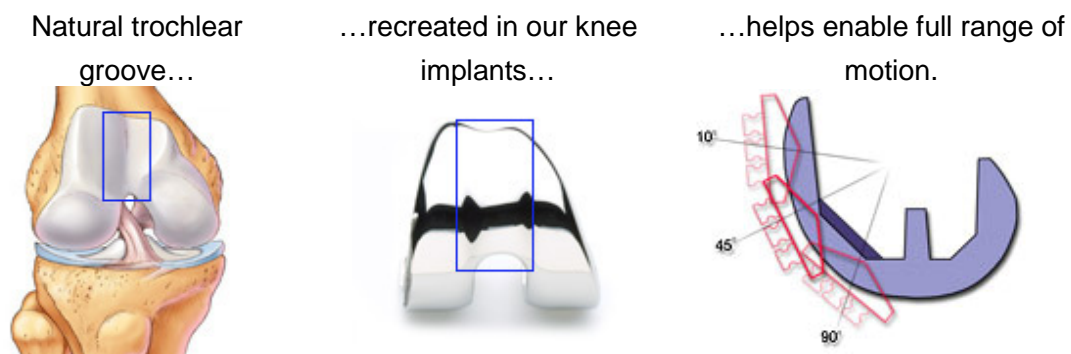
# Knee Replacement

[Watch a Total Knee Replacement](#)

## Knee Pain

A primary goal of joint replacement is to reduce pain. Though most patients experience some pain during recovery from surgery, they find that the long-term relief is a welcome liberation from the pain caused by diseased knee joints.

Zimmer's knee systems feature a unique "deepened trochlear groove" in the femoral component. This allows smooth movement of the patella through full range of motion, which reduces clicking, stress and wear.



(Illustration by: Calhoon, Borman, Mueller)

## Alignment

Joint alignment follows the same principals as aligning your tires: if your joints are out of alignment, one side is going to wear down. This can leave patients with moderate to severe bowleggedness (varus) or knock-knees (valgus).

Zimmer has special instrumentation to help surgeons to replicate natural, optimum alignment.

This alignment is crucial. If the knee joint is not aligned correctly during total knee replacement, it could result in several problems, including:

1. Decreased range of motion

## 2. Patellar wear

The patella acts as a delicate balancing point for the muscles that propel the knee in motion. If it's out of balance, it won't be able to leverage the same degree of movement, and the added stress can eventually wear it down.

## 3. Instability

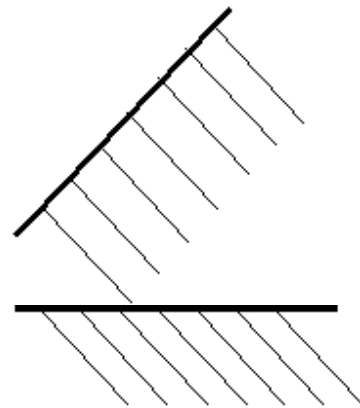
If the implant doesn't fit correctly, or if the ligaments can't stretch enough to support it, it will become unstable

## 4. Limited bending and extending

The patient's ability to flex and extend his/her leg will be compromised.

### **Trabecular Effect**

Trabeculae are small bundles of fibers that make up the framework of organs, including the spongy interior cancellous bone. Consider the analogy of balancing something on sticks: the sticks must be at a 90° angle to provide full support:



Cutting on a posterior slope provides a 90° angle for full support.

A perpendicular cut, on the other hand, puts the tibial tray at an awkward angle to the trabeculae, weakening the support structure.

### **Bone Preservation**

Bone is living tissue and like most living things, needs stimulation to stay healthy.

A challenge in knee implant design is not to let the implant do all the work. If the implant overly shields the bone from stress ("stress-shielding"), bone can be resorbed or broken down by the body, resulting in bone loss for the patient.

On the other hand, if the bone is required to take on too much stress, abnormal growth can occur – called "adaptive remodeling."

Zimmer implants are designed to provide a balance between stable fit and natural stress loading.

## Stability

Ligaments are tough bands of tissue that connect the thigh bone and the shin bone. They stretch as you flex, extend and rotate your knee.

The cruciate ligaments are so called because they cross over each other, forming a cross when viewed from the side.

- The anterior cruciate ligament (ACL) keeps the shin from sliding forward.
- The posterior cruciate ligament (PCL) behind the ACL keeps the thigh bone from sliding all the way back.

The medial collateral ligament on the inside of the knee and the lateral collateral ligament on the outside of the knee prevent the thigh bone from sliding sideways when you walk.

When putting in knee implants, 99% of surgeons cut or “sacrifice” the ACL since it’s usually too damaged and tends to get in the way during surgery. To compensate for the ACL, the knee implant includes a tibial insert to provide stability.

The decision whether or not to sacrifice the PCL is more subjective, depending upon surgeon philosophy, functionality, etc. Some surgeons want to retain as much of the natural anatomy as possible. Others feel that a partially damaged ligament (as is usually the case) is unpredictable after surgery.

If the PCL is sacrificed, it must be substituted.

Zimmer offers varying degrees of stability in its knee implant designs to compensate for deficient ligaments -- from the minimum thickness for patients with good quality ligaments to the posterior stabilized design (bottom left) to provide the most stability for patients whose PCL’s have been sacrificed.



## Range of Motion

A goal of total knee replacement is to help patients gain as much range of motion (ROM) as possible. Zimmer implants' "deepened trochlear groove" feature helps maximize ROM.

Another unique feature is the Natural-Knee's asymmetrical tibial baseplate, one of the first designs to truly replicate the natural anatomy.

Designing surgeon Dr. Aaron Hofmann's team measured 100 cadaveric tibias and then designed the tibial baseplate to precisely match the asymmetrical shape. This helps minimize the "pinching" often found in symmetrical baseplates and maximize the patient's range of motion.

### **Lifetime of Implant**

The longevity of a prosthetic knee (how long it will last) varies from patient to patient. It depends on many factors, such as a patient's physical condition and activity level, body weight and the surgical technique. A prosthetic joint is not as strong or durable as a natural, healthy joint, and there is no guarantee that a prosthetic joint will last the rest of a patient's life. All prosthetic knees may need to be revised (replaced) at some point.

## **Preparing for Joint Replacement Surgery**

### ***Three Weeks Before Surgery***

*This information is intended to be an overview of activities that you may experience during joint replacement surgery. It is not intended to replace any instructions provided by your physician, and we would encourage you to discuss this information with your physician.*



- **Store frequently used items in easy to reach cabinets, such as cleaning supplies and canned foods.** Avoid very high or very low shelves as these may require you to use a step stool or kneel.
- **Make and freeze meals or stock up on frozen dinners before surgery so that meal preparation is easier and requires less effort.** You may want to

make a list of items you will need to prepare meals and go to the supermarket. You should plan on making enough meals for one week or so.

- **Contact friends/family for support.** Friends/family may be needed to assist with activities such as driving and moving items in your home for safety. The Arthritis Foundation also has a support network that can provide emotional support. You can contact your local chapter or go to the [Arthritis Foundation](#) web site for more information.
- **Check the safety of your home to prevent falls or tripping .** Move long electrical and telephone cords against the wall, remove rugs, and place a non-skid mat in your bathtub. You may want to prepare a bed in the downstairs level of you home to reduce climbing stairs. Have an elevated chair or high seated chair with arms in every room if possible.

### ***Two Weeks Before Surgery***

- **Anti-inflammatory medications** Your physician may not want you to take any aspirin or non-steroidal anti-inflammatory medications (Advil, Ibuprofen, Motrin, etc.) for the 14 days before surgery. You may be able to take Tylenol or medicines with acetaminophen. Be sure to discuss this with your physician.
- **Purchase or borrow the special equipment your physician recommends .** This may include an elevated commode and small devices such as a grabber. You can find these items at most hospital supply sections of large drug stores or in mail order catalogs from department stores. Practice using the items at home.

### **Partial Knee Surgery**

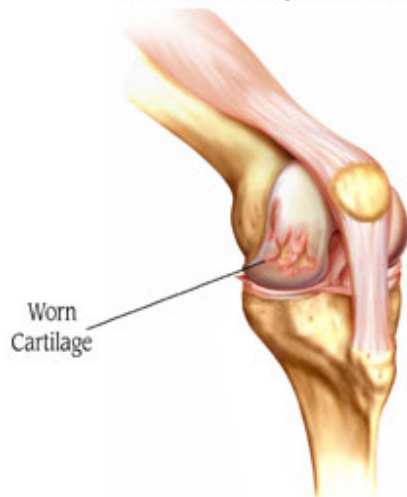
The knee joint is where the end of the upper leg bone (femur) meets the top of the lower leg bone (tibia). The end of the femur consists of two condyles, which are like runners or wheels on each side of the bone. These condyles sit on top of the tibia, which is like a platform that is slightly dished on each side. Thus, on each side of the joint, there is an area of contact between the two bones. When the knee is bent, the condyles of the femur roll and slide on top of the tibia at these two areas of contact. A third bone, the kneecap (patella), glides over the front and end of the femur.

### Healthy knee joint surfaces



In a healthy knee joint, the surfaces of these bones are very smooth and covered with a tough protective tissue called cartilage. Arthritis causes damage to one or more of the bone surfaces and cartilage where the bones rub together. These damaged surfaces eventually become painful.

### Arthritic knee joint surfaces



There are many ways to treat the pain caused by arthritis. One way is knee replacement surgery. This is usually considered last, after other methods of treatment have been tried. In knee replacement surgery, the bone surfaces and cartilage that have been damaged by arthritis are removed and replaced with artificial surfaces made of metal and a very durable plastic material. We call these artificial surfaces "implants."

If the surfaces on both sides of the bones, as well as the underside of the patella, are significantly damaged, a **total knee** replacement is usually considered. In some cases, however, there may be significant damage on only one side of the joint. In these cases, a **partial (unicompartmental) knee** replacement may be considered. In a partial knee replacement, only one side of the joint is resurfaced.

The decision to have any kind of knee replacement surgery should be made very carefully after consulting your doctor and learning as much as you can about the knee joint, arthritis, and the surgery.

### ***Getting to the Joint***

For a partial knee replacement, the patient is first taken into the operating room and given anesthesia. After the anesthesia has taken effect, the skin around the knee is scrubbed thoroughly clean and then swabbed with an antiseptic liquid. The knee is flexed about 90 degrees and the lower portion of the leg, including the foot, is placed in a special device to securely hold it in place during the surgery. A tourniquet is usually applied to the upper portion of the leg to help slow the flow of blood.

An incision is made through the skin, muscle, and other soft tissue until the damaged bone surfaces are exposed. Recent advances in instrumentation and surgical technique have allowed surgeons to perform some partial knee replacements through a much smaller skin incision than those used traditionally.



## ***Removing the Damaged Bone Surfaces***

The damaged bone surfaces and cartilage are then removed. Precision guides are used to help make sure that the cuts are made at the correct angles so the bones will align properly after the new surfaces (implants) are attached.

Small amounts of the bone surface are removed from the front, end, and back of the damaged condyle on the femur. This shapes the bone so the implants will fit properly.

### **Surfaces of femoral condyle removed**



A small portion of the top surface of one side of the tibia is also removed, making the end of the bone flat.



## ***Attaching the Implants***

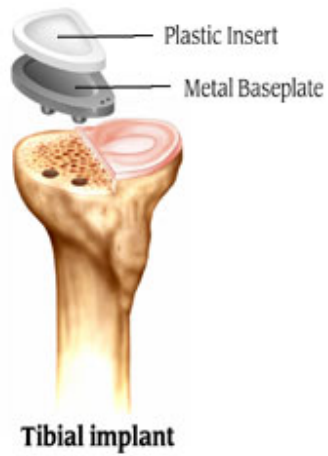
An implant is attached to both of the bones, using a special kind of cement for bones. These implants are shaped so that the knee joint will move in a way that is very similar to the way the joint moved when it was healthy.

The implant that fits over the end of the femur is made of metal. Its surface is rounded and very smooth.

Femoral implant



There are two types of implants that fit over the top of the tibia, one consists of two parts. A metal baseplate fits over the part of the bone that was cut flat. The plastic insert is then attached to the baseplate to serve as the articulating surface between the tray and the metal femoral implant that covers the end of the femur. The other type of implant consists of a single piece of plastic that is similar in shape to the metal baseplate and plastic combination. Your doctor will decide which implant is better for you.



**Knee joint with partial knee implants**



### ***Closing the Wound***

If necessary, the surgeon may adjust the ligaments that surround the knee to achieve the best possible knee function.

When all of the implants are in place, the surgeon sews the layers of tissue back into their proper position. A plastic tube may be inserted into the wound to allow liquids to drain from the site during the first few hours after surgery. The edges of the skin are then sewn together, and the knee is wrapped in a sterile bandage. The patient is then taken to the recovery room.

### **Your Total Knee Surgery**

There are several ways to treat the pain caused by arthritis. One way is total knee replacement surgery. The decision to have total knee replacement surgery should be made very carefully after consulting your doctor and learning as much as you can about the knee joint, arthritis, and the surgery.

In total knee replacement surgery, the bone surfaces and cartilage that have been damaged by arthritis are removed and replaced with artificial surfaces made of metal and a plastic material. We call these artificial surfaces “implants,” or “prostheses.”

### ***During Surgery***

The patient is first taken into the operating room and given anesthesia. After the anesthesia has taken effect, the skin around the knee is thoroughly scrubbed with an antiseptic liquid. The knee is flexed about 90 degrees and the lower portion of the leg, including the foot, is placed in a special device to securely hold it in place during the surgery. Usually a tourniquet is then applied to the upper portion of the leg to help slow the flow of blood during the surgery. An incision of appropriate size is then made.

**Knee Prepared for Surgery**



### **Removing the Damaged Bone Surfaces**

The damaged bone surfaces and cartilage are then removed by the surgeon. Precision instruments and guides are used to help make sure the cuts are made at the correct angles so the bones will align properly after the new surfaces (implants) are attached.

Small amounts of the bone surface are removed from the front, end, and back of the femur. This shapes the bone so the implants will fit properly. The amount of bone that is removed depends on the amount of bone that has been damaged by the arthritis.

A small portion of the top surface of the tibia is also removed, making the end of the bone flat.

The back surface of the patella (kneecap) is also removed.

**Damaged Tibial Bone Surface Removed**



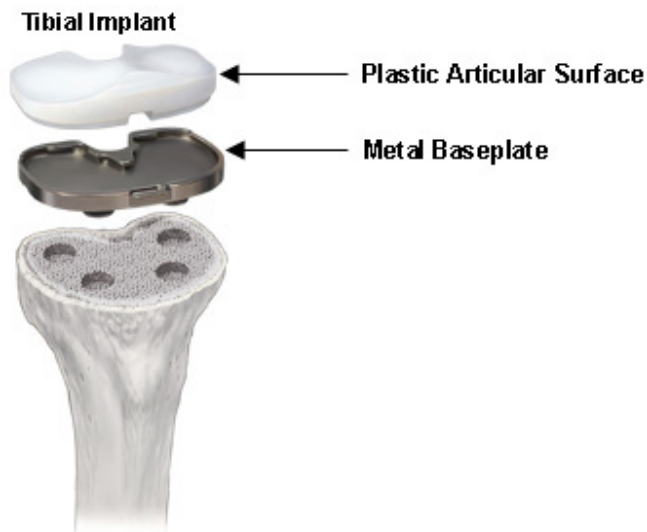
### **Attaching the Implants**

An implant is attached to each of the three bones. These implants are designed so that the knee joint will move in a way that is very similar to the way the joint moved when it was healthy. The implants are attached using a special kind of cement for bones.

The implant that fits over the end of the femur is made of metal. Its surface is rounded and very smooth, covering the front and back of the bone as well as the end.



The implant that fits over the top of the tibia usually consists of two parts. A metal baseplate fits over the part of the bone that was cut flat. A durable plastic articular surface is then attached to the baseplate to serve as a spacer between the baseplate and the metal implant that covers the end of the femur.



The implant that covers the back of the patella is also made of a durable plastic.

### Patellar Implant



Artificial knee implants come in many designs. Some designs may have pegs, requiring small holes to be drilled into the bone after the damaged surfaces have been removed. Others may have central stems. In addition, some designs may allow screws to be used on the lower implant to provide added attachment security. The surgeon will choose the implant design that best meets the patient's needs.

**Implants with Pegged Design**



**Implants with Stemmed Design**



### ***Closing the Wound***

If necessary, the surgeon may adjust the ligaments that surround the knee to achieve the best possible knee function.

When all of the implants are in place and the ligaments are properly adjusted, the surgeon sews the layers of tissue back into their proper position. A plastic tube may be inserted into the wound to allow liquids to drain from the site during the first few hours after surgery. The edges of the skin are then sewn together, and the knee is wrapped in a sterile bandage. The patient is then taken to the recovery room.

## **After Knee Surgery**

The following are some ways to incorporate movement after you have had knee replacement surgery. Discuss these techniques with your physicians and orthopedist before attempting them. Your therapist may modify some these techniques depending upon your situation (i.e., age, weight, and procedure). Only do the techniques that are recommended by your physician and/or therapist.

### ***Lying Down***

To help promote flexibility in your knee while lying down, place a rolled-up bath towel under your ankle. As your knee straightens, you may feel a gentle stretch in your thigh area.



### ***Sitting Up***

For the first few times, your physician or therapist may move and hold your leg. Soon you will sit at the edge of the bed with your foot resting on a small stool without assistance. You may be asked to stretch your operated leg and rest it on a chair.



### ***Standing With Support***

For a while your physician or therapist may help you stand. A safety belt may be placed around your waist to support you just in case you feel dizzy. A splint may also be placed around your operated leg to keep it from moving and protect your knee as you stand.



## ***Using a Walker***

Once you can stand, you will probably use a walker to help you keep your balance. Initially you will be told to place only a small amount of weight on your operated leg as you walk. As your knee becomes stronger, your doctor will tell you when you can increase the amount of weight placed on your operated leg.

*Step 1* With both hands lift and scoot the walker and place it a few inches in front of you. Be certain all four legs of the walker are down before proceeding.

*Step 2* Lean on the walker and let it help support your weight. Step forward and through the walker with your operated leg. Be careful not to wrap your leg around the legs of the walker.

*Step 3* Hold on to the walker firmly with both hands, then step forward placing your though the walker.



unoperated leg

## ***Walking with Crutches***

Once your knee and leg muscles are strong enough, your physician or physical therapist may recommend crutches instead of using a walker. Your therapist will give you guidelines on how far and how long you may walk.

*Step 1* With the crutches firmly in place, place pressure on your hands, not on your armpits.

*Step 2* Move the operated leg and both crutches forward at the same time.

*Step 3* Looking up and straight ahead, first step through the crutches with the operated leg followed by your unoperated leg.



## ***Walking Up Stairs with Crutches***

With your crutches upright on the floor and firmly planted for support, lift your unoperated leg and place it on the step. Leaning forward on the crutches, lift yourself up. Use the crutches and your unoperated leg to support your weight. Now lift your operated leg up onto the step. You may want to have someone help you the first few times until you become comfortable with stairs.



## ***Walking Down Stairs with Crutches***

Place your crutches and your operated leg on the lower step. Use the crutches for balance and lower yourself carefully down onto the step moving the crutches as you move the operated leg. Again, you may wish to have someone assist you the first few times you try this.



## ***Once You Are at Home***

It is very important that you follow your surgeon's instructions. The following suggestions should be discussed with your surgeon before your hospital discharge:

- If you will be using a walker or crutches to assist with walking, ask your doctor how much weight you may put on your operated leg.
- Remember that you will probably tire more easily than usual. You may want to plan a rest period of 30 to 60 minutes mid-morning and mid-afternoon.

- It is safer and easier to get in and out of chairs using both arms and you should avoid low or overstuffed furniture. To increase your comfort, use a cushion or pillow to raise your body while seated.
- An elevated toilet seat may reduce stress to your hips and knees as you sit and stand.
- A shelf placed in the shower at chest height may reduce having to bend to retrieve items while in the shower.
- A bathtub seat (bench) allows you to sit while bathing for increased safety and comfort.
- A long-handled bath sponge may be used to reach lower legs. Women can also purchase razor extenders to shave their legs.
- Avoid sweeping, mopping, and running the vacuum cleaner. Use long-handled feather dusters for dusting high and low items. Your doctor will tell you when it is okay to sweep, mop, and vacuum.
- You may ride in a car, but you must follow your doctor's instructions for how to get in and out of the vehicle. You can raise the height of the car seat with pillows to protect your hips and knees as well. Your doctor will talk with you about when you can drive, typically within four to six weeks after surgery. If you have a car with manual transmission, talk with your doctor about driving limitations. Make sure you can brake the car without discomfort before you attempt to drive in traffic.
- Constipation is a common problem for patients following surgery. This is usually due to your limited activity and any pain medications you may be taking. Discuss your diet with your doctor. It should include fresh fruits and vegetables as well as eight full glasses of liquid each day, unless your doctor tells you otherwise.
- Your doctor will probably give you a prescription for pain pills. Please follow your doctor's instructions concerning these medications.
- Some swelling around the incision is normal. You will find it more comfortable to wear loose clothing to avoid pressure on the incision. Ask your doctor or other qualified health professional about appropriate wound care.

## **Materials Used in Orthopaedic Implants**

### ***Overview***

As you would expect, orthopaedic implants are very “high tech.” Their designs can be quite complex, and the materials used to make them, called biomaterials, are highly

developed. Examples of biomaterials include Titanium, cobalt-chrome, polyethylene, and *Trabecular Metal*<sup>™</sup> Material.

In the United States the FDA requires extensive testing before a new material may be used in an orthopaedic implant. The materials most commonly used have a long history of clinical use with great success.

There are many different biomaterials, but there is no single biomaterial that is best for all implants and all patients. The specific requirements of an implant material vary depending on how the implant is designed to be used. Also, like medicine, biomaterials can produce side effects like microscopic debris, increased ion levels in the blood or urine, or inflammation. These are rare, but you should be aware of the possibility. For these reasons, your doctor will evaluate you individually and carefully consider the material that is used to manufacture your implant, along with its design.

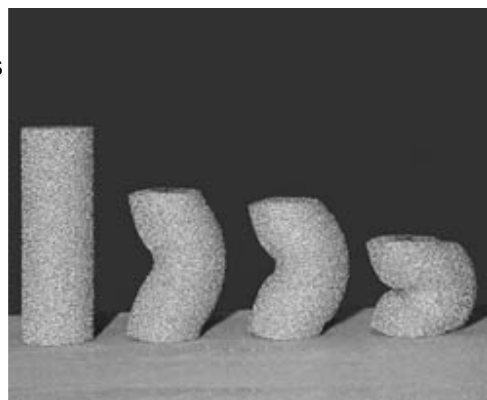
The content on biomaterials is intended to answer some of the most common questions about the biomaterials used in orthopaedic implants, but it cannot tell you what material is best for your implant. Only your doctor can tell you that, so be sure to discuss your specific questions with him. If you have more questions for your surgeon about the biomaterials in your implant, be sure to ask during your visits.

## **Materials Used in Orthopaedic Implants**

### ***Importance of Materials***

As you go about your daily activities, an implant may encounter mechanical forces that tend to push on it, pull on it, bend it, scrape it, or cause its parts to rub together. These forces can cause the implant to break or wear out over time.

It is also subjected to the many natural chemicals inside your body. Although normal, some of these chemicals may tend to corrode some materials. In order for an implant to perform under these conditions, it must be made from materials that can withstand these forces and chemicals.



Whether an implant is designed to replace a joint, or help repair a fracture, several physical and biological characteristics are important when selecting the material for the implant. For example, an implant must be sufficiently strong, flexible, and resistant to wear. But that doesn't mean the strongest material, or the most flexible material, is the best material.

The ideal implant material would have physical characteristics that match those of the bone it is replacing or reinforcing. After all, orthopaedic implants are attached to your bones, and they must work *with* your bones to restore function. This usually requires a balance of physical characteristics. Your bones, for example, are strong but flexible. This combination helps them withstand forces as high as several times your weight without breaking.

Obviously, physical characteristics are important to orthopaedic materials; but biological characteristics are just as important. When we talk about biological characteristics, we mean the biological effect the material has on the body, as well as the effect the body has on the material.

## **Materials Used in Orthopaedic Implants**

### ***Physical Characteristics—Strength and Flexibility***

#### **Strength**

Certainly, an orthopaedic implant should be designed to be as strong as possible. Even in everyday activities, you will place high levels of mechanical stress on your bones and joints. An implant must be able to withstand these stresses day to day without breaking or permanently changing its shape. It should also be designed to withstand the accumulated effect of repeating these stresses.

#### **Flexibility**

While strength characteristics of implants are important, they must also be somewhat flexible to avoid shielding of bones from stress (what doctors call "stress shielding"). To understand stress shielding, you have to understand that the human body may tend to reduce or eliminate its own parts when they are not used. Your muscles, for example, can be built up by lifting weights. But when you stop lifting weights, you will eventually begin to lose the extra muscle that you have built up.

Similarly, your bones can remain strong only if they are regularly placed under a reasonable stress. And if they are never stressed, your body will actually begin to lose bone tissue, causing the remaining bone to become weak.

When stress is applied to an orthopaedic implant that is very stiff, the implant absorbs most of the stress. But when stress is applied to a more flexible implant, some of the stress passes through the implant so it can be shared with the surrounding bone. That's good because your bones need to be stressed. That's why flexibility is important.

## **Materials Used in Orthopaedic Implants**

### ***Common Materials Used in Orthopaedic Implants***

Generally, the most common materials used in orthopaedic implants are metals and a type of plastic called polyethylene. These two material types are combined in most joint implants, that is, one component is made from metal, and one from polyethylene. When properly designed and implanted, the two components can rub together smoothly while minimizing wear.

While some pure metals have excellent characteristics for use as implants, most metal implants are made from a mixture of two or more metals. These mixed metals are called alloys. By combining metals, a new material can be created that has a good balance of the desired characteristics. The most common metal alloys used in orthopaedic implants are stainless steels, cobalt-chromium alloys, and titanium alloys.

#### **Stainless Steel**

Stainless steel is a very strong alloy, and is most often used in implants that are intended to help repair fractures, such as bone plates, bone screws, pins, and rods. Stainless steel is made mostly of iron, with other metals such as chromium or molybdenum added to make it more resistant to corrosion. There are many different types of stainless steel. The stainless steels used in orthopaedic implants are designed to resist the normal chemicals found in the human body.

#### **Cobalt-chromium Alloys**

Cobalt-chromium alloys are also strong, hard, biocompatible, and corrosion resistant. These alloys are used in a variety of joint replacement implants, as well as some fracture repair implants, that require a long service life. While cobalt-chromium alloys contain mostly cobalt and chromium, they also include other metals, such as molybdenum, to increase their strength.

#### **Titanium Alloys**

Titanium alloys are considered to be biocompatible. They are the most flexible of all orthopaedic alloys. They are also lighter weight than most other orthopaedic alloys. Consisting mostly of titanium, they also contain varying degrees of other metals, such as aluminum and vanadium.

### **Titanium**

Pure titanium may also be used in some implants where high strength is not required. It is used, for example, to make fiber metal, which is a layer of metal fibers bonded to the surface of an implant to allow the bone to grow into the implant, or cement to flow into the implant, for a better grip.

### **Tantalum**

Tantalum is a pure metal with excellent physical and biological characteristics. It is flexible, corrosion resistant, and biocompatible.

### **Polyethylene**

Polyethylene is a type of plastic commonly used on the surface of one implant that is designed to contact another implant, as in a joint replacement. You may recognize polyethylene as the material used to make milk cartons. But don't worry; your implant is not made from recycled milk cartons. The polyethylene used in orthopaedic implants is a much higher grade. In fact, a special type of medical-grade polyethylene was developed specifically for use in orthopaedic implants.

Polyethylene is very durable when it comes into contact with other materials. When a metal implant moves on a polyethylene surface, as it does in most joint replacements, the contact is very smooth and the amount of wear is minimal.

Patients who are younger or more active may benefit from polyethylene with even more resistance to wear. This can be accomplished through a process called crosslinking, which creates stronger bonds between the elements that make up the polyethylene. The appropriate amount of crosslinking depends on the type of implant. For example, the surface of a hip implant may require a different degree of crosslinking than the surface of a knee implant.

## **Materials Used in Orthopaedic Implants**

### ***Other Materials***

#### **Ceramics**

Ceramic materials are usually made by pressing and heating metal oxides (typically aluminum oxide and zirconium oxide) until they become very hard. These ceramic materials are strong, resistant to wear, and biocompatible. They are used mostly to make implant surfaces that rub together but do not require flexibility, as in the surfaces of a hip joint.

### **Composite Materials**

Composite materials are made by mixing two or more separate materials without creating a chemical bond between the materials. For example, carbon fibers may be added to another material to provide additional strength, but the two materials do not combine in a way that creates a new material. Metal alloys and ceramics are not considered to be composite materials because their ingredients are chemically bonded to create a new material.

On a larger scale, two layers of different materials can be combined to create a composite material with the desired characteristics. The stem of a hip implant, for example, may consist of layers of two different materials that together provide the desired combination of strength and flexibility.

### **Trabecular Metal™ Material**

*Trabecular Metal* material is made from tantalum over carbon. It is strong, flexible, and biocompatible. The structure of *Trabecular Metal* material is similar to the structure of bone. It is very porous, which means it has small spaces or pores. New tissue can grow into these pores and help hold the implant in place.

### **Bioabsorbable Materials**

Bioabsorbable materials are designed to be absorbed by the body when their job is complete. They are made from a biocompatible plastic that can be dissolved by normal body fluids. Many sutures used today in all types of surgery are bioabsorbable. These bioabsorbable materials may also be used in implants that reattach soft tissue to bone.

### **Silicone**

Silicone is a rubbery material that is very flexible. In orthopaedics, it is most commonly used in implants that replace the joints of the toes.