

Knee Arthroplasty

Knee Replacement:

Arthro' meaning JOINT and 'Plasty' meaning REPAIR or MOLDING

Knee replacement surgery may replace all the damaged parts of your knee (total knee replacement **TKR**) or just part of your knee (partial knee replacement). In a total knee replacement, the surgeon replaces 3 surfaces:

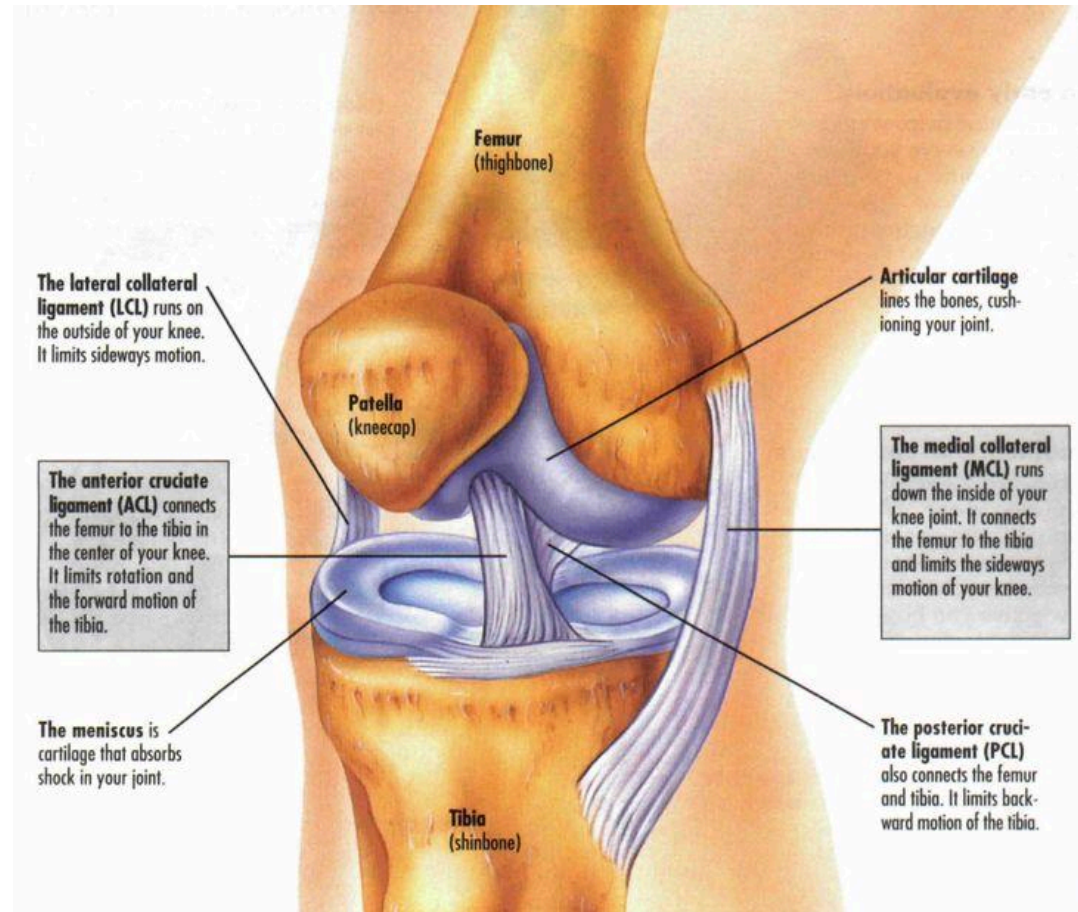
- The end of the tibia
- The end of the femur
- The back of the patella (kneecap)

Knee: Atypical Hinge Joint

Formed by the articulation of the femur, tibia and patella



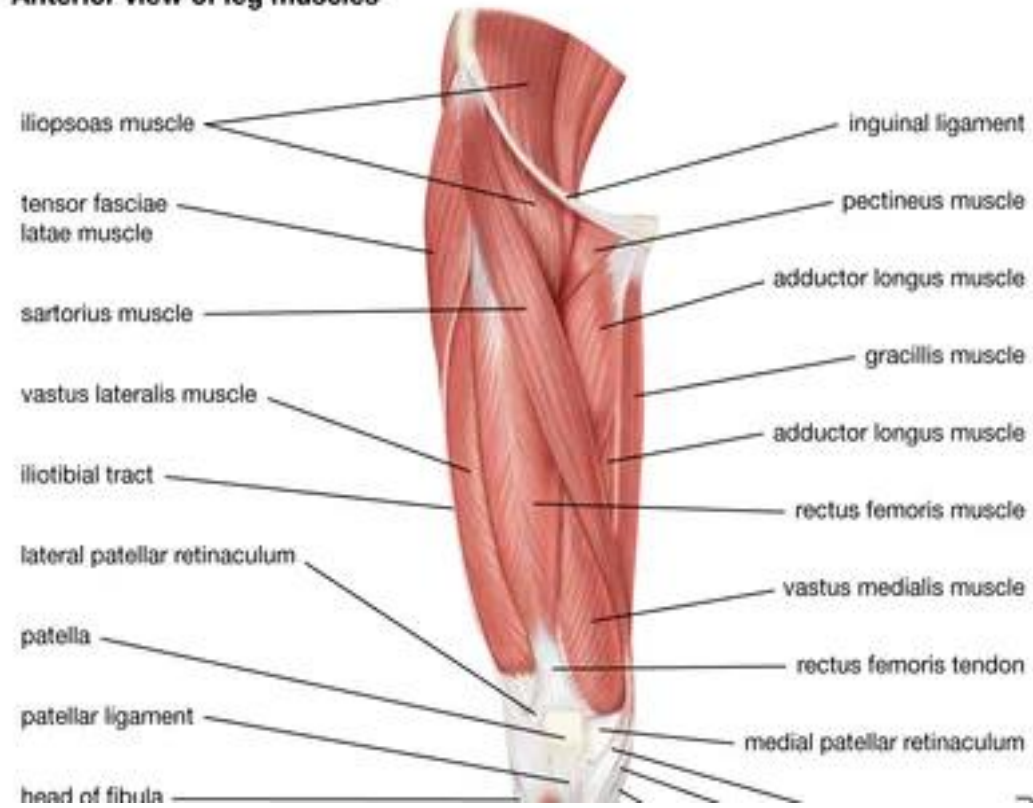
Ligaments of the Knee Joint



Anterior Muscles of the Knee Joint

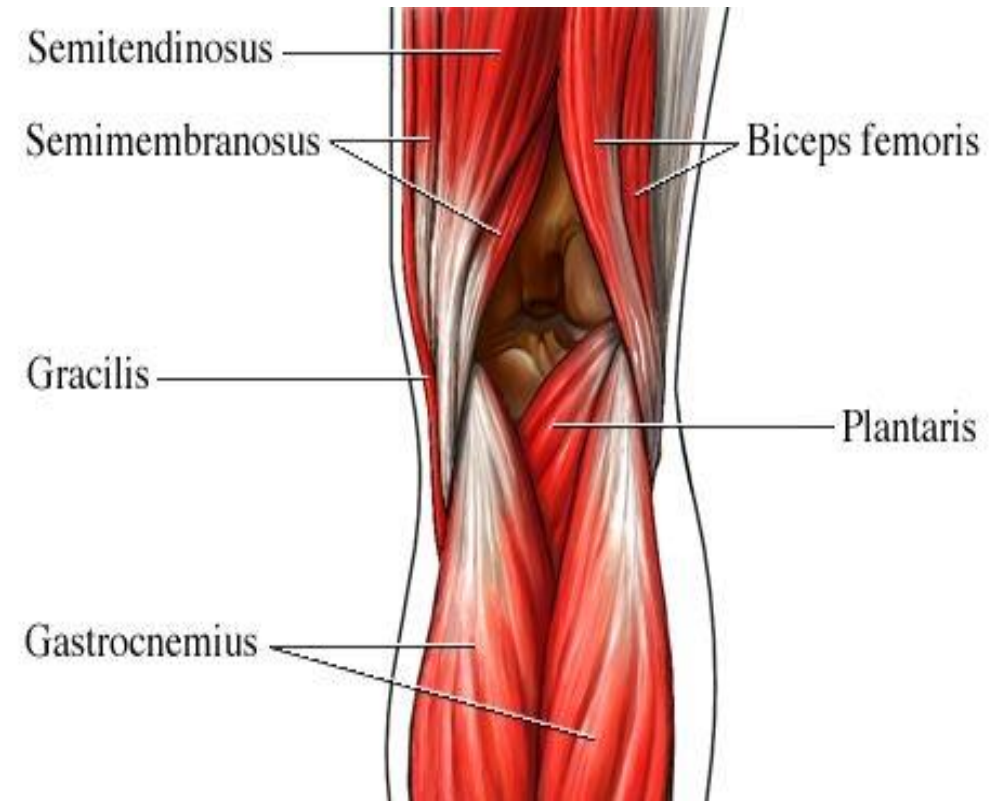
- The primary anterior muscles of the knee joint are the Quadriceps Femoris group (Rectus Femoris, Vastus Lateralis, Vastus Medialis, Vastus Intermedius) and the Sartorius, all located in the front of the thigh; they mainly function to **extend the knee (straighten the leg)**, with the quadriceps forming a powerful group inserting via the patella and patellar tendon to the tibia, while the sartorius assists in flexion and rotation.

Anterior view of leg muscles



Posterior Knee Muscles

- **Main Knee Flexors (Hamstrings)**
- Biceps Femoris: Lateral (outer) side; two heads (long & short).
- Semitendinosus: Medial (inner) side, long, thin tendon.
- Semimembranosus: Medial side, broad, flat muscle.
- **Other Key Posterior Muscles**
- Gastrocnemius: The large calf muscle (two heads) that crosses the knee and ankle, aiding in plantarflexion (pointing toes down).
- Popliteus: A deep, small muscle at the back of the knee, crucial for unlocking the knee joint.
- Plantaris: A small muscle (often absent) with a long tendon, assists gastrocnemius.
- Gracilis: Medial thigh muscle that crosses the knee to assist flexion.
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Lateral muscles of the Knee

Key Muscles & Structures

- **Vastus Lateralis:** The main muscle on the outer thigh, extending the knee.
- **Biceps Femoris:** A hamstring muscle at the back/outer thigh, flexing the knee and extending the hip.
- **Iliotibial (IT) Band:** A thick band of fascia running down the outside of the thigh from the hip to the shin, stabilizing the knee and facilitating lateral movement.
- **Tensor Fasciae Latae (TFL) & Gluteus Maximus:** These muscles attach to the IT Band, influencing its tension and function.



Medial Muscles of the knee

- **Muscles inserting on the proximal tibia**
- [Pes anserinus:](#)
- This is a common insertion point for three muscles on the anteromedial aspect of the proximal tibia, just below the joint line:
- **Sartorius**
- **Gracilis**
- **Semitendinosus**
- [Adductor magnus:](#)
- The posterior-distal part of this muscle's tendon, the adductor tubercle, gives rise to the posterior oblique ligament (POL) which attaches to the posterior medial corner of the tibia and is sometimes considered an atavistic variation with muscle fibers.
- [Popliteus:](#)
- This muscle originates from the lateral femoral condyle and lateral meniscus but inserts on the proximal, posterior tibia, making it a medial muscle with a lateral origin.
- **Muscles with origin on the medial femur**
- [Medial collateral ligament \(MCL\):](#) Originates from the medial epicondyle of the femur and has a distal attachment on the medial aspect of the tibia.
- **Medial head of the gastrocnemius:** Originates from the medial femoral condyle.
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Movements of the knee joint

The knee joint's primary movements are **flexion** (bending) and **extension** (straightening), allowing it to act like a hinge joint. A small amount of medial and lateral rotation is also possible, which is most noticeable when the knee is bent. These movements are controlled by the quadriceps muscles (for extension) and the hamstrings (for flexion)

Muscle control

- Quadriceps:
- This muscle group on the front of the thigh is responsible for extending the knee.
- Hamstrings:
- This group of muscles on the back of the thigh is responsible for flexing the knee.
- Popliteus muscle:
- This muscle at the back of the knee helps to "unlock" the fully extended knee, allowing it to bend.

Screw-home mechanism:

At the end of extension, the knee "locks" for stability through a slight rotation. The popliteus muscle then "unlocks" it to allow for flexion.

Medical Reasons for Knee Replacement

- **Osteoarthritis**: The most common reason, occurring when the cartilage cushion between the bones wears down.
- **Rheumatoid arthritis**: An inflammatory condition that damages the joint.
- **Other arthritis types**: Including gout and other inflammatory conditions.
- **Knee injuries**: Severe damage from accidents or other trauma.
- **Congenital issues**: Joints that were not formed correctly.

Considerations for Knee Replacement

Knee replacement is considered when severe pain and stiffness significantly limit daily activities, sleep, and mobility, and have not responded to conservative treatments like medication and physical therapy. Key criteria include radiographic evidence of advanced joint disease (such as severe arthritis) and pain that interferes with quality of life.

- **Pain and function**
- **Severe, persistent pain:**
 - You experience constant pain, even at rest, which interferes with sleep and daily life.
- **Limited mobility:**
 - Your ability to walk, climb stairs, or perform everyday tasks is severely restricted.
- **Stiffness and swelling:**
 - You have chronic swelling and stiffness that limits the knee's range of motion.
- **Pain relief failure:**
 - Your pain does not improve with pain relievers, injections, or physical therapy.

Radiographic and physical findings

- **Severe arthritis:** X-rays show advanced joint disease, often described as bone-on-bone contact due to significant cartilage loss.
- **Joint deformity:** Some patients may develop a visible bowing of the leg.
- **Physical examination:** A doctor will assess your knee's motion, stability, and strength to understand the extent of the damage.

Pre-operative care

Reduce fall risks:

- Remove loose rugs, electrical cords, and other trip hazards.

Organize your space:

- Place essential items like clothes, toiletries, and kitchen supplies within easy reach to avoid bending or stretching.

Set up your recovery area:

Arrange a comfortable space on one floor, if possible, and consider a stable chair with armrests and a footstool to elevate your leg.

Install safety equipment:

- Place safety bars in your shower and a toilet seat riser if you have a low toilet.

Prepare meals:

- Stock your freezer with pre-made meals to make things easier after the surgery.

Pre-operative Exercise

- Begin a Pilates regimen at least three months before the procedure to strengthen the whole body, not just the legs.
- This helps build a stronger foundation for recovery and can improve function pre-operatively.

SURGICAL PROCEDURE

- **Incision:** The surgeon makes an incision at the front of the knee to access the joint.
- **Exposure:** Muscles and ligaments are separated to expose the femur (thigh bone), tibia (shin bone), and patella (kneecap).
- **Resurfacing:** Damaged cartilage and some bone are removed from the ends of the femur and tibia.
- **Patella (Optional):** The underside of the kneecap may also be reshaped and resurfaced.
- **Implantation:** Metal components are attached to the ends of the femur and tibia.
- A plastic spacer is inserted between them to create a smooth gliding surface, mimicking healthy cartilage.
- Implants are secured with bone cement (most common) or allowed to grow into porous surfaces.
- **Closure:** The joint is tested for stability and motion, then the incision is closed.

Key Components

- **Femoral Component**: A metal cap that replaces the end of the thigh bone (femur).
- **Tibial Component**: A metal tray that sits on the top of the shin bone (tibia).
- **Plastic Spacer**: A piece of ultra-high-molecular-weight polyethylene (UHMWPE) that glides between the metal parts, acting as new cartilage.
- **Patellar Button (Optional)**: A plastic button that resurfaces the back of the kneecap (patella) if it's also arthritic.



What happens to the muscles surrounding the knee in TKR?

Muscle separation:

Muscles are typically not reattached after a knee replacement because they are usually **not fully detached**. In a traditional surgery, the quadriceps tendon is separated from the kneecap and then **sutured back together** after the procedure is complete

No reattachment needed:

In more modern, [muscle-sparing approaches](#), the surgeon moves the kneecap to the side to access the joint, and the muscles are preserved.

The muscles remain connected and are simply put back in their original position after the procedure is finished. This approach is intended to **reduce pain and muscle trauma** and shorten the recovery period

Why the Meniscus is Removed in TKR?

- Room for Implants:
- Removing the meniscus creates space for the metal femoral (thigh) and tibial (shin) components to be attached to the bone.
- Eliminates Pain:
- The damaged meniscus is often a source of pain and inflammation, and removing it resolves this issue.
- Proper Implant Fit:
- It ensures the artificial joint surfaces align correctly for optimal function, as the implants replace the cartilage and meniscus.

What Replaces the Meniscus's Function

- Plastic Spacer:
- A high-density polyethylene (plastic) spacer is placed between the metal components, acting as the new cushion and bearing surface.
- Implant Design:
- The design of the implants, particularly in posterior-stabilized knees, incorporates features that take over the ligaments' (like the PCL) stabilizing functions, as these are often cut.

What happens to the knee ligaments in TKR?

Ligaments Typically Kept:

- [Medial Collateral Ligament \(MCL\)](#): On the inner side of the knee, usually preserved for stability.
- [Lateral Collateral Ligament \(LCL\)](#): On the outer side, also usually preserved.
- [Posterior Cruciate Ligament \(PCL\)](#): Often retained, though sometimes removed in older designs or specific cases.

Ligaments Typically Removed:

- [Anterior Cruciate Ligament \(ACL\)](#): Routinely removed in most TKRs.

How Stability is Maintained:

- [Implant Design:](#)
- The new artificial joint components provide much of the stability, working with your remaining tissues.
- [Ligament Balancing:](#)
- Surgeons carefully balance and tension the preserved ligaments (MCL, LCL, PCL) to ensure proper movement and prevent looseness.
- [Muscle Strength:](#)
- Strong surrounding muscles (quads, hamstrings, calves) also play a vital role in supporting the new joint.

Common Minor Issues Post-operatively

- **Stiffness & Swelling:** Very frequent, especially early on, due to inflammation and scar tissue formation, affecting bending and straightening.
- **Paraesthesia:** Tingling or numbness in the area.
- **Ongoing Pain:** Up to 20% of patients experience persistent discomfort

Risks of knee replacement surgery?

The chance of having problems after knee replacement surgery is low. But there are risks after any surgery. Possible problems after knee replacement surgery include:

- Infection
- Blood clots
- [Heart attack](#)
- [Stroke](#)
- Nerve damage
- Scarring that limits how far you can bend your knee
- Your age, general health, and how active you are can all affect your risk of having a problem after knee replacement surgery.
- The implants used for knee replacements are durable, but they may loosen or become worn over time. If this happens, another surgery may be needed to replace the loose or worn parts.

Post-operative treatment

- Before discharge, you and your care team will decide the best course of action. Your options, based on insurance coverage, may include:
- Transfer to an in-patient rehabilitation facility, where you'll have physical therapy every day to help speed your recovery and get you ready to move on your own at home.
- Physical therapy at home with a therapist who comes to you.
- Physical therapy at an outpatient center that you go to for each session.

Active physiotherapy is required

- After surgery, scar tissue can build up around the quad tendon and other soft tissues. While scar tissue is very important in the initial healing process as it protects the incision, it can:
- Keep you from being able to fully straighten your knee or bend it enough to get in and out of chairs or car seats comfortably.
- Prevent you from restoring a normal walking pattern.
- To prevent excess scar tissue from forming, it is important to be consistent with your prescribed **physical therapy exercises**.

Post-operative Recovery

- **Phase 1: Initial recovery (0–4 weeks)**
 - **Focus:** Reducing pain and swelling, and regaining basic movement.
 - **Activities:** Gentle exercises like leg raises, ankle pumps, and bending and straightening the knee while sitting. You will likely use an assistive device like a walker or cane to walk.
- **Phase 2: Strengthening (4–12 weeks)**
 - **Focus:** Building strength and improving range of motion.
 - **Activities:** More intense exercises to increase strength and flexibility. Low-impact activities like swimming or stationary biking may be introduced. By the end of this phase, you should be able to flex your knee to at least 120 degrees and walk for longer periods without a cane.
- **Phase 3: Long-term maintenance (12 weeks and beyond)**
 - **Focus:** Maintaining strength, flexibility, and function.
 - **Activities:** You will continue with a home exercise program to maintain the progress you've made. Your doctor may clear you to slowly resume more activities, such as golf, Pilates or yoga

Important considerations

- **Committing to recovery.** Having any [kind of surgery](#), especially joint surgery, requires time, money and a commitment to making it work. You'll need to make [preparations before surgery](#) and carefully follow your treatment and recovery program afterward. If you are willing to maintain a healthy weight and stick to your physical therapy routine, your chances of having a long-term improvement in your joint are much greater.
- **A second, or revision, surgery.** Younger patients do have a higher rate of failure and early [revision](#) because of obesity, more activity and because they are living longer than older patients. How much you have to have redone depends on what part of the implant has failed. For instance, debris from the implant's wear can damage bone. So, if you don't follow up with your doctor for 10 to 15 years and then have bone damage, you may need to remove old components and replace them with all new ones
- **Unrealistic expectations.** Many patients think they will go back to a normal lifestyle, that they will be pain-free or that they can return to a higher level of activity than we recommend. Your knee will be better, but never normal."

Post-operative errors

- **Skipping or Underestimating Physical Therapy (PT):**

PT is crucial for regaining strength, flexibility, and mobility; skipping sessions leads to stiffness and poor outcomes.

- **Overdoing Activities Too Soon:**

Rushing back to high-impact activities or overexerting the knee before tissues heal can damage the new joint and delay recovery.

- **Ignoring Pain & Warning Signs:**

While some pain is normal, persistent worsening pain, severe swelling, redness, warmth, or fever can signal infection or blood clots, requiring immediate medical attention.

- **Poor Nutrition & Hydration:**

Inadequate nutrients and water slow cellular repair, while a diet lacking protein, fruits, and veggies hinders tissue healing.

- **Insufficient Home Preparation & Lifestyle Changes:**

Not having help, failing to remove hazards, or trying to manage stairs/daily tasks too soon puts stress on the knee and increases fall risk.

Other Common Errors to Avoid:

- **Stopping walking aids too early:** Use crutches or a walker as long as recommended to protect the joint and build strength.
- **Improper Wound Care:** Follow instructions to prevent infection.
- **Straying from Pain Medication Plan:** Take prescribed meds to manage pain enough

Phase 2 (4 to 8 weeks)

Always consult and co-ordinate exercises with the PT if your client wants to start or recommence Pilates. This phase will vary on the client's age, commitment and level of fitness before the surgery.

Always commence with **checking the client's gait**. Uneven gait or limping has to be addressed immediately. It may be due to muscle weakness, pain or habit. It is important to stress that correct gait will **strengthen muscles much quicker** and relieve pain. Most of the therapy relies on a balanced, even gait.

Early Recovery Exercises (Focus on Range of Motion & Strength) Below are the exercises that PT's usually give patients to do at home:

- [Ankle Pumps](#): Move foot up and down to improve circulation and prevent clots.
- [Quad Sets](#) (Thigh Contractions): Lie or sit with leg straight, tighten thigh muscles, press knee down, hold, then relax.
- **Heel Slides (Knee Bends)**: Slide heel toward buttocks, bending the knee, hold, then straighten.
- **Straight Leg Raises (SLRs)**: Tighten quad, lift straight leg off the bed/floor, hold, then lower slowly.
- [Assisted Knee Bends](#): Use a towel or your other foot to gently help bend the knee while lying down.

Intermediate & Advanced Exercises (Building Strength & Stability)

- [Standing Knee Flexion/Bends](#): Hold a counter, bend knee bringing heel back, hold, then lower.
- [Leg Extensions](#) (Seated): Sit, lift foot, straighten knee, hold briefly, then lower.
- **Stationary Cycling**: Start with a recumbent bike, pedal as able to build muscle and mobility.
- [Weight Shifts](#): Stand holding support, shift weight side-to-side onto surgical leg.

Phase 3 (12 weeks post-op)

As recovery progresses, you can move to more advanced exercises to **train the body holistically**. The replaced knee has to be incorporated with holistic movements.

The cueing in all exercises will focus on attaining full knee range:

FULL extension (180 degrees) and Flexion (at least 100 to 120 degrees) for functional use using the set movement patterns of the Pilates Method.

Pilates reformer exercises: Start with **Basic Reformer** level to strengthen muscles around the knee in a controlled, low-impact way.

Modified mat work: Start with **Basic Mat** exercises. Close the chain initially by using props to assist stability.

Tower/Cadillac, Wunda Chair and all classical Pilates equipment at the **Beginner Level**

Standing balance work: As balance improves, incorporate exercises that challenge stability, such as standing using the Magic Circle, the Wall series and balancing on one leg.

Always end the session with practicing **daily living functions**, such as sitting to standing, posture in standing and work ergonomics. Also guide the client's choices of exercising at a gym, doing pool exercises and returning to their favorite sporting activity.

Avoid High-Impact: Stay away from activities that stress the implant (running, skiing, high-impact sports).

Low-Impact Options: Walking, swimming, and cycling (stationary or regular) are great for long-term fitness.

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