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Total Knee Arthroplasty: QUESTIONS FOR A SPECIALIST

We are seeing a steady increase in the prevalence of knee arthritis affecting adults in the United States. In fact, more than 10% of men and women over the age of 60 have symptomatic arthritis, which likely arises from an increase in the population's age and adults who are more active. Unfortunately, the pain and instability of knee arthritis can greatly affect your quality of life and overall mobility.

When the symptoms first begin, patients often use braces and over-the-counter pain relieving creams and medications; however, as arthritis advances, symptoms can become unresponsive. Your physician may recommend physical therapy or intra-articular (inside the joint) steroid injections. If these nonoperative treatments fail, your doctor may recommend total knee replacement. Researchers project that by the year 2030 surgeons will perform approximately 1.2 million total knee arthroplasty (replacement) (TKA) procedures each year.

What types of arthritis affect the knee?

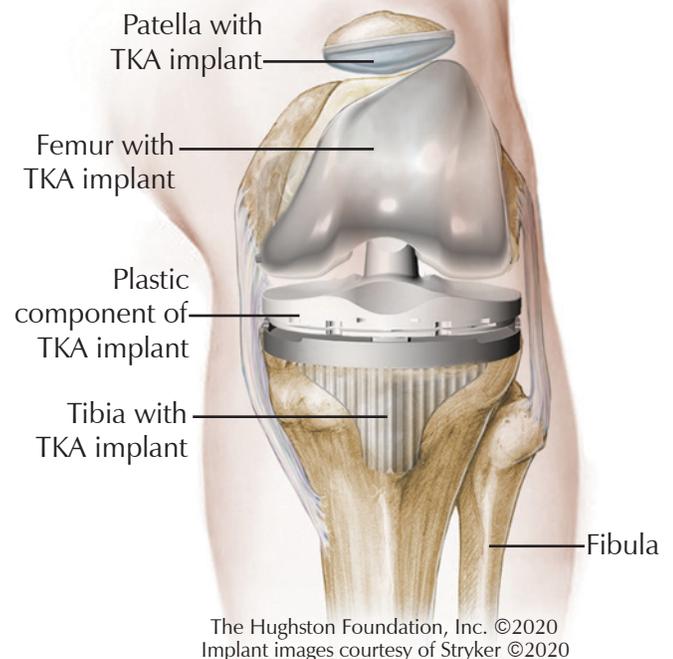
There are 3 major types of arthritis that doctors see in the knee: primary osteoarthritis (OA) (**Fig. 1**), post-traumatic osteoarthritis, and inflammatory arthritis. Primary osteoarthritis is the most common type of arthritis orthopaedic surgeons treat because it results from normal wear and tear on joints and may have a genetic component. Post-traumatic osteoarthritis, which results from an injury to the knee that occurred years prior, can be from sports, trauma, or infection that damaged the surrounding ligaments (tissue that connects bones) or cartilage (hard slippery tissues that cover the ends of bones) that over time has led to deterioration of the joint. Another common type of arthritis, inflammatory arthritis, is seen in patients who have autoimmune disorders (the body's immune system attacks healthy tissue, including joints), such as rheumatoid arthritis or psoriatic arthritis. A rheumatologist often manages these types of

Fig. 1. Total knee arthroplasty (TKA)

Anterior (front view) of bent knee with osteoarthritis arthritis



Anterior (front view) of bent knee with TKA implant



arthritis with medications. Despite the treatment, unfortunately the result is often joint destruction and an eventual need for knee replacement.

Why does my knee hurt?

There are several reasons why knee arthritis can cause pain. In the early stages, the cartilage of the joint begins to degenerate, leading to inflammation within the joint, which produces enzymes that trigger pain receptors. As the cartilage continues to wear, the space within the joint reduces allowing the bones to move closer together. As the joint space narrows, the supporting ligaments loosen and the knee becomes unstable. With activity, this instability causes the ligaments to stretch and activates the pain fibers around the knee. In the last stages of arthritis, the cartilage can completely wear away producing bone-on-bone contact. The mechanical grinding of bone against bone causes significant pain and loss of function.

What are the nonoperative treatments for knee arthritis?

Although treatment recommendations depend on the severity of your symptoms, all patients warrant an attempt at nonoperative care. You should take simple measures first, including changes in activities and maintaining a healthy weight. For active patients, changing workout routines that lessen the impact on your knees may be beneficial, such as substituting higher impact exercises with low-impact aerobics. Physical therapy for lower leg muscle strengthening can help with mild to moderate knee arthritis as increasing muscle strength can compensate for the deteriorating knee joint and associated instability. At the same time, over-the-counter and prescription anti-inflammatory medications including ibuprofen, naproxen sodium, diclofenac, meloxicam, and celecoxib can relieve some of the discomfort. Acetaminophen is also an effective pain reliever with fewer gastrointestinal side effects than anti-inflammatories.

Additionally, knee braces can help with mild to moderate arthritis and they range from inexpensive compression sleeves to medical-grade hinged devices. Knee braces provide added stability for deteriorating knee cartilage, as well as increase sensory feedback, known as proprioception, on the knee's position in space. This feedback helps with knee stability, which subsequently reduces pain.

Furthermore, intra-articular injections are a successful nonoperative treatment option performed by orthopaedic physicians. Most injections consist of a combination of local anesthetics and corticosteroid. These types of injections reduce inflammation within the joint leading to pain reduction. Viscosupplementation (a gel-like fluid, consisting of hyaluronic acid) is another injection option that may provide significant relief. These injections add

lubrication to the joint for decreased pain with movement and some studies have indicated they may also have the added benefit of anti-inflammatory properties.

Who is a candidate for a total knee replacement?

Surgeons consider total knee arthroplasty for patients who have end-stage arthritis of the joint. Usually, patients who have had at least 6 months or more of symptoms and have failed to have significant relief with nonoperative treatments including medications, injections, physical therapy, and activity modifications are candidates for knee replacement. The patient's radiographs (x-rays) usually show bone-on-bone contact between the femur (thighbone) and tibia (shinbone). Some patients, especially those with inflammatory arthritis, may not progress to end-stage arthritis before the pain becomes severe enough for knee replacement.

Total knee replacement is a major surgery; therefore, the patient must be healthy enough to undergo the surgery and complete postoperative rehabilitation. To prepare for knee replacement, your primary care provider will complete a physical to ensure that you are healthy enough for surgery and will usually order a chest x-ray, electrocardiogram (EKG) of your heart, and basic blood work. Patients who have medical conditions may need clearance from specialists, such as a pulmonologist (respiratory specialist) or cardiologist (heart doctor).

How is a total knee arthroplasty performed?

Total knee replacement is performed through an incision about 6 to 8 inches in length in the front of the knee. The surgeon can perform the surgery using general anesthesia or spinal anesthesia and a local nerve block (injection) for postoperative pain control. Surgery typically lasts about an hour and involves removing part of the end of the thighbone and top of the shinbone. The surgeon then covers the surfaces with properly sized metal implants and inserts a piece of medical grade plastic in between (**Fig. 2**). The surgeon closes the incision in layers and covers the wound with a sterile dressing. Patients who are otherwise healthy and are able to ambulate can go home the same day, but some people may require a 1- to 2-night stay in the hospital for proper pain control and physical therapy.

Is there a preferred technique or method?

Although numerous companies make knee replacement implants, studies do not show that any particular device is superior to any other. Most orthopedic surgeons use a few implant companies that they are familiar and comfortable with. Surgeons often secure the implants to the bone with a specialized bone cement. This is a grout-like material that the doctor mixes in the operating room and places on the bone along with the implant. The surgeon then holds the new parts in place while the cement hardens. A newer technique for implants does not involve cement. These types of implants have a specialized coating on the underside that

contacts the bone. This coating allows the bone to grow onto the implant providing a secure fit to the bone end. No current studies show that any type of implant fixation is superior to the other. Other exciting technologies deal with how the surgeon cuts the bone during surgery. Your surgeon may discuss methods, such as computer assisted navigation, custom cutting guides, as well as robotic assisted surgery. These are all new technologies that may offer advantages over conventional surgery; however, the approach or method is often your surgeon's preference and what is best for you.

What happens after surgery?

Physical therapy is the most important part of recovery and begins on the day of surgery. Therapy starts with walking and bending the knee to maintain range of motion. Patients must begin moving the knee right away to prevent stiffness. The therapist can help with maintaining motion and instructing patients on exercises. This motion will be uncomfortable at first but tends to get better over the first few weeks of recovery. You will have multiple therapy visits each week and patients are to perform exercises at home as well. Although patients may need a walking aid such as a rolling walker or cane, within the first few weeks, most patients can ambulate without assistance by their 6 weeks follow-up appointment.

What are some potential complications?

The most dreaded complication following knee replacement is infection. For this reason, your surgeon will prescribe a dose of antibiotics before the procedure and usually at least 1 or 2 doses after surgery to reduce your risk of infection. Should an infection arise, treatment ranges from oral antibiotics if it is localized to the skin, or you may need further surgery for cleaning the joint if the infection appears to be around the implant components.

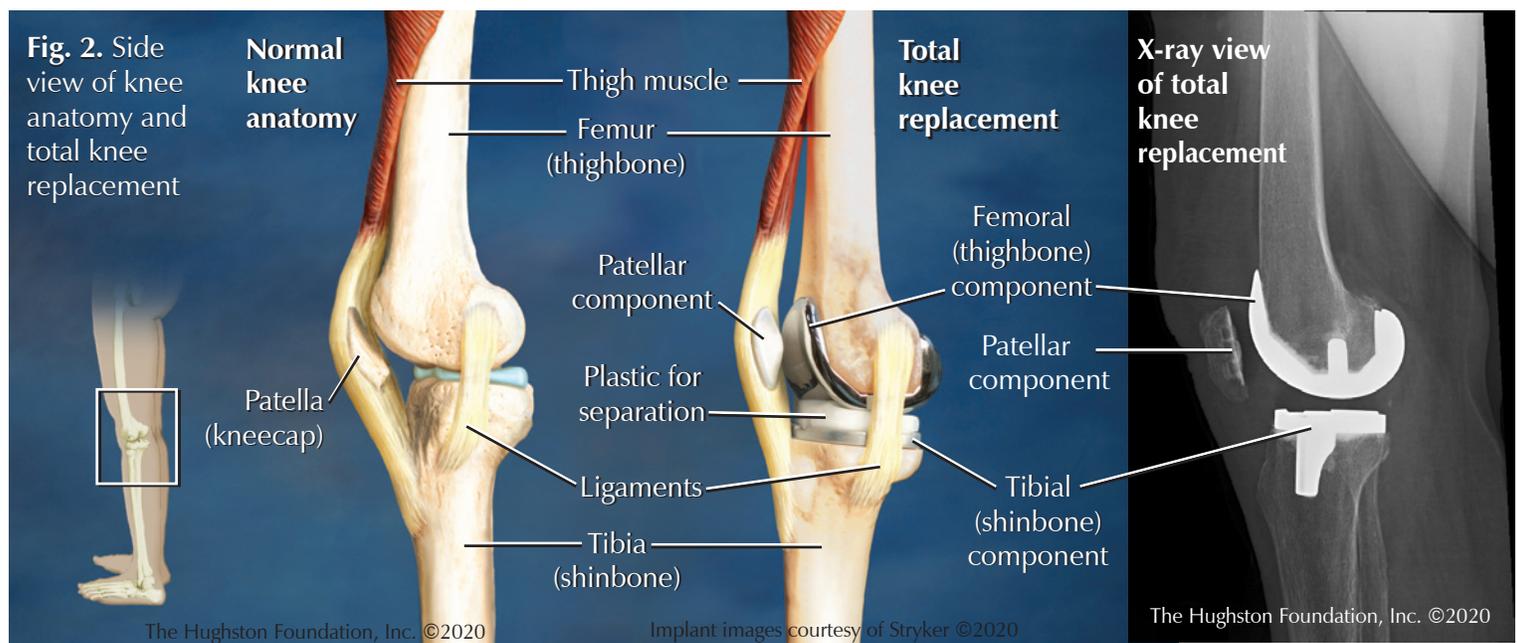
Additionally, blood clots can form in the leg after a knee replacement because of the surgery and decreased activity. For that reason, your doctor may place you on a blood thinner for up to 6 weeks after surgery. If you have few risk factors and are relatively healthy, you may only need aspirin. If you have a few medical problems or a history of previous blood clots, your doctor may prescribe a stronger blood thinner medication or an injection.

Stiffness is also a feared complication. This is why physical therapists stress early and frequent motion during rehabilitation. If stiffness persists and limits function, a return to the operating room for a manipulation may be necessary to regain motion. After the manipulation, the patient will restart an aggressive physical therapy regimen. The best way to prevent complications is to follow the postoperative instructions provided by your orthopaedic surgeon.

What are the outcomes of knee replacement?

The vast majority of patients have significant improvements in pain and function following total knee arthroplasty. Recovery can vary but most patients have improvement with decreased pain at 6 weeks after surgery. With proper therapy and activity, improvements in pains and function will continue for 6 months to 1 year after surgery. You may experience occasional aches and pain around the knee implant with weather changes and increased activity. The hope is that only over-the-counter pain medications are necessary to control these minor aches and pains. Active patients can often return to recreational activities without restriction; however, you must take care to avoid excessive strain on the joint, which can affect its longevity.

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Concussion Software

A concussion is a brain injury, and regardless of whether it is mild, moderate, or severe, it has the potential of long-term consequences. The Centers for Disease Control and Prevention reports that mild traumatic brain injuries (mTBI), also called concussions, account for nearly 75% of all traumatic brain injuries (TBI). Researchers define a concussion as a transient change of brain function caused by a biomechanical force to the brain after a head injury. During a concussion, brain cells or neuronal axons pull, stretch, tear, and twist, damaging the brain's electrical chemical pathways. Often, the results are a decrease in brain cell activity and reduction in blood flow within the brain, which can lead to temporary or permanent neurological signs and symptoms (**Box 1**).

Box 1. Concussions can affect:

- **Cognitive function**
Impairing your attention or memory
- **Motor function**
Weakness, poor coordination, and balance problems
- **Sensations**
Loss of hearing, vision, perception, or touch
- **Emotions**
Depression, anxiety, aggression, or personality changes

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Adults aged 65 and older and children under 14 years old lead the demographics of age-related falls that result in a concussion while motor vehicle accidents are the third leading cause of TBI among all age groups. Concussions are more frequent in teenagers, young adults, males, and people who are engaged in high-impact, physical activities, such as a contact sport. Since sports-related concussions are the leading cause of mTBI, all 50 states address concussion management in school athletics by using return-to-play protocols to protect athletes. The question is then, when can an athlete safely return to sports?

After a head injury

Following a concussion, patients can experience a number of clinical symptoms, such as headaches, dizziness, depression, memory loss, confusion, blurred vision, and balance problems (**Box 2**). These symptoms can occur with or without loss of consciousness. Some physicians use post-concussion syndrome to describe a range of residual symptoms that persist despite a lack of evidence of brain abnormalities on magnetic resonance imaging (MRI) or computerized tomography (CT) scans. While traditional imaging modalities—such as CT, MRI, position emission tomography (PET) scan, and single-photon emission computerized tomography (SPECT) scans—provide information on brain anatomy, metabolism,

Box 2. TBI Signs and Symptoms

Observable TBI Signs:

- Appearing dazed or stunned
- Forgetting an instruction
- Moving clumsily
- Answering questions slowly
- Losing consciousness (even briefly)
- Showing mood, behavior, or personality changes
- Being unable to recall events prior to or after a hit or fall

Symptoms reported by patients with TBI

- Headache or pressure in the head
- Nausea or vomiting
- Balance problems or dizziness
- Double or blurry vision
- Sensitivity to light or noise
- Sensation of feeling sluggish
- Concentration or memory problems
- Confusion
- Not “feeling right” or “feeling down”
- Mood changes, such as irritability, sadness, nervousness, anxiety, or acting more emotional than normal
- Changes in sleep patterns

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energy consumption, and blood flow, they do not provide information on the functional brain or help diagnose concussions. More specifically, these imaging modalities do not allow us to quantify how the underlying brain networks are performing, such as memory, attention, pain, or depression. Other functional assessment methods, including clinical assessment and neurocognitive tools, reveal only clinical effects and symptoms.

How your brain works

The brain contains a complex cellular network of around 100 billion neurons with each neuron connected to around 10,000 neighboring neurons. Neurons “speak” to each other using special chemicals called neurotransmitters. The messages from neuron to neuron flow through electrochemical signals. The signal from 1 neuron is miniscule and not detectable; however, when there are coordinated electrical pulses from groups of neurons, a detectable brainwave is produced. Brainwaves, much like smart phone applications (“apps”), allow us to communicate our thoughts, emotions, and behaviors.

Testing for concussion

Evoked response electroencephalogram (EEG) testing is a new modality that allows concussion specialists to objectively measure and assess the brain's network of electrical functions (our brain “apps”) at rest and during mental tasks. Researchers report that the inclusion of

Fig. 1. The WAVi EEG device is a noninvasive method that tracks and records brainwave patterns

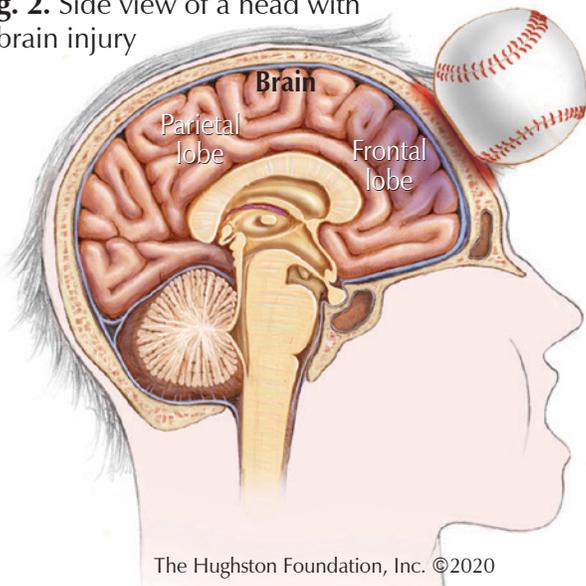


Images courtesy of WAVi ©2020

evoked EEG with concussion diagnostics can improve accuracies to above 95%. More importantly though, they have also found that evoked EEG's are a powerful measure of brain recovery that can detect deficits even after symptoms have resolved. Physicians use WAVi, which is a new device that uses the EEG technology, to help them diagnose, treat, and plan the long-term management of concussions.

The WAVi EEG device is a noninvasive method that tracks and records brain wave patterns via a number of electrodes during a 20-minute scan (**Fig. 1**). This device evokes an EEG to see how well the brain is processing. The evoked EEG signal most sensitive to concussion appears as a positive voltage occurring on average 300 milliseconds after the stimulus, and is therefore known as the P300 response. Physicians can see the P300 signal on an EEG as a fast, single electrical spike in response to a sensory, cognitive, or motor stimulus. Researchers believe the P300 signal comes from the parietal lobe, a portion of the brain, which has an important role in decision-making and response to stimulation (**Fig. 2**). The WAVi device can measure how efficiently the brain is able to use available brain "apps" to complete a given task. For example, the WAVi will look at brain regions "apps" that are not activating consistently

Fig. 2. Side view of a head with a brain injury



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and are therefore not functioning well. This information helps the physician determine the direction of rehabilitation efforts, the types of tasks one should be practicing most, and the training approaches to speed recovery.

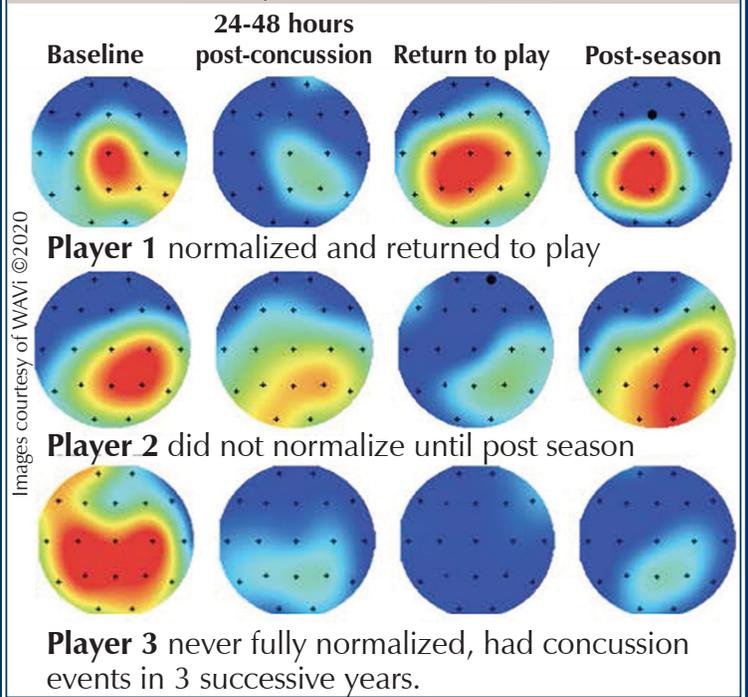
Additionally, the WAVi brain scan allows for a visual representation of the electrical changes in brain neural pathways following a concussion. Depicted is a heat-map visual representation of 3 players: before and after a concussion and at the end of the season (**Fig. 3**). Colors near the red spectrum reflect higher brain voltages, which shows normal functioning of the brain and colors near the blue spectrum reflect lower brain voltages that show the brain after a concussion. Additionally, this graph shows the significant shift from red spectrum to blue spectrum—see the left column, which is a baseline scan to the second column—after a player sustained a concussion. The pictogram of player 3 indicates the electrophysiology of the brain has not returned to normal following the concussion.

On the forefront of concussion care

Concussions cause measurable changes in the electrophysiological functioning of the brain. As such, concussed participants often pass clinical tests while still displaying electrophysiological deficits in the form of a delayed P300. By using evoked response EEGs and technology such as WAVi, we are on the forefront of concussion care and better able to determine when an athlete has still not recovered enough to safely resume their sport.

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Fig. 3. WAVi heat-map of before and after a concussion
Colors near the red spectrum - shows normal brain function
Colors near the blue spectrum - shows the brain after a concussion



Images courtesy of WAVi ©2020

Hand Arthritis

For many reasons 2020 has been a challenging year. In particular, it has made practicing medicine challenging because many patients have been worried about visiting their doctors for fear of exposing themselves to COVID-19. This has left patients searching for answers online. Although the Internet has a wealth of information available, a quick search of symptoms for hand pain and stiffness can be overwhelming. As an orthopaedic hand surgeon, one of the most common presenting complaints is hand pain related to arthritis. Fortunately, when I see these patients, I am able to offer both nonsurgical and operative solutions. When it comes to musculoskeletal disorders of the hand, the key is receiving the appropriate examination, diagnosis, and treatment from an orthopaedic physician who specializes in treatment of hand injuries and disease.

Changes in the hand

Hand arthritis is a common term used to describe the degenerative changes that take place within the small joints of the hand. Arthritis can have varying causes including: osteoarthritis (a degenerative disease caused by overuse), post-traumatic injury, or inflammatory, which is related to metabolic or autoimmune disorders, such as gout, pseudogout, rheumatoid, or psoriatic arthritis. The hand comprises all structures beyond the wrist joint and contains many different bones, tendons (tissues connecting muscle to bone), nerves, and vascular structures. The joints of the hand include the carpometacarpal (CMC), the metacarpophalangeal (MCP), the proximal interphalangeal (PIP), and the distal interphalangeal (DIP) bones (**Fig. 1**).

Osteoarthritis refers to the constellation of radiographic (x-ray) findings associated with wear and tear of the joint cartilage that has no other underlying cause. When cartilage breaks down, the joint loses its natural shock absorber; and therefore, the force transmits to the bone. X-rays may show a narrow joint space that depicts bone-on-bone disease. Additionally, bone spurs or cysts are common findings in patients presenting with osteoarthritis. Additionally, patients often experience inflammation, pain, and swelling around the joint.

Those at risk for developing osteoarthritis are typically elderly patients with a history of overuse of the hands. Furthermore, recent studies have linked osteoporosis to degenerative changes throughout the body including thumb basal joint arthritis. Therefore, primary care physicians should screen patients who are at risk for osteopenia or osteoporosis and discuss medical management for these diseases. Physicians may recommend patients to take vitamin D, calcium, or other anti-bone resorption supplements.

Nonsurgical treatment

Physicians approach the treatment for arthritis in the small joints of the hand differently than the larger joints in the body. Patients may present with “start up” pain related to the initiation of motion. Hand surgeons encourage finger range of motion exercises to minimize the risk of stiffness. The mainstay of treatment for hand arthritis relies on maximizing nonoperative modalities such as ice, heat, and anti-inflammatory medication. For stiffness, heat can help to loosen the connective tissue in the muscles, tendons, and ligaments (tissues connecting 2 bones) and may improve overall range of motion. Ice can help to minimize swelling, inflammation, and pain. Anti-inflammatory medications such as ibuprofen, naproxen, and meloxicam can help patients overcome a particular flare-up and minimize the inflammatory cascade that results in pain.

Fig. 1. Normal anatomy of the hand joints and a hand x-ray

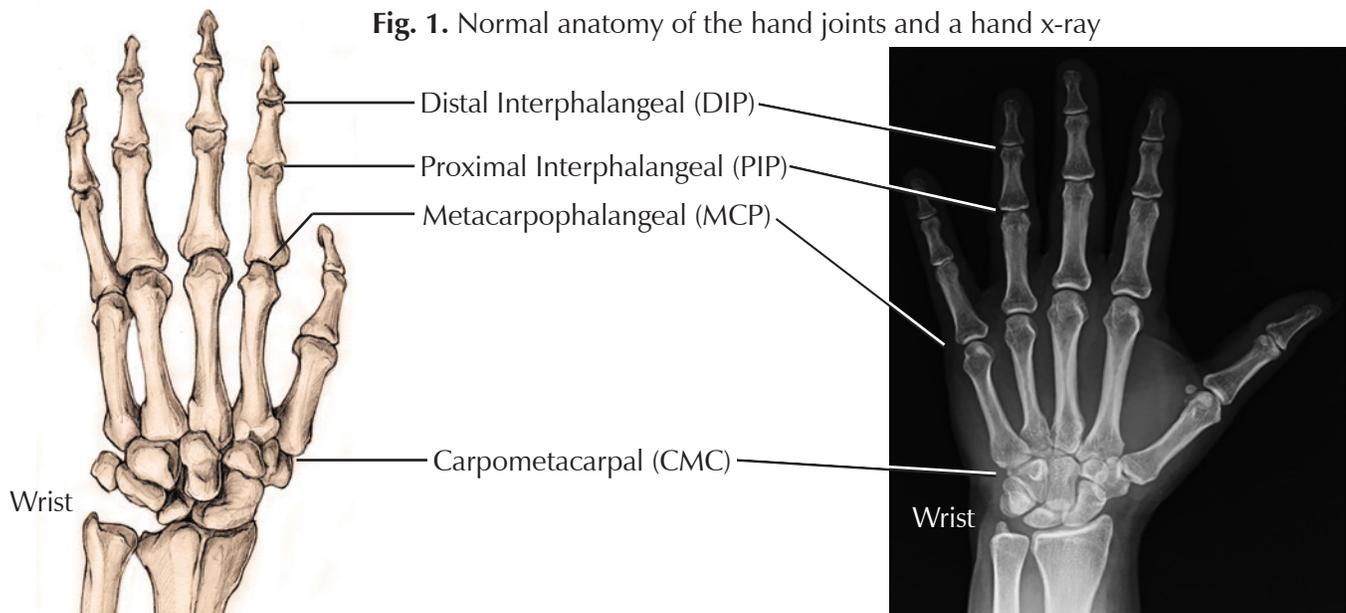


Fig. 2. Joint replacement exchanging the surfaces with a plastic implant



Unfortunately, there are patients who present with unrelenting symptoms despite nonsurgical treatment. Depending on the diagnosis, intermittent steroid injections may help to ease symptoms. Basal joint arthritis is the most common location for primary arthritis in the hand and often responds well to a steroid injection. According to a 2015 article in the *Hand* journal, when comparing placebo, hyaluronic acid, and steroid injections for thumb arthritis, only steroid injections demonstrated any long-term clinical improvement in symptoms. However, physicians should inform patients that symptoms could return after an injection because the steroid medication does not change the underlying degenerative injury to the joint.

Surgical treatment

Surgical treatment varies based on the joint in question, though the options are to either replace the joint or fuse the joint. A joint replacement procedure eliminates the arthritic joint by exchanging the surfaces with metal and plastic implants (**Fig. 2**). A fusion procedure eliminates the arthritis by permanently connecting 2 bones together (**Fig. 3**). Joint replacement affords the ability to maintain motion whereas fusion inhibits motion. However, both procedures help to eliminate pain.

Additionally, each procedure has its own rehabilitation regimen. Joint replacement allows for early range of motion to minimize the risk of joint stiffness. On the other hand, patients undergoing a joint fusion require a longer period of disuse, typically until the fusion takes. This could be several weeks to months depending on the patient's risk factors, such as other medical problems, or a history of smoking. Patients must also minimize the stress at the joint level following a joint fusion because too much stress can result in broken hardware or a nonunion.

As one can imagine, the outcomes vary depending on the patient's demand and the type of procedure performed. However, patients are generally pleased with

Fig. 3. Partial wrist fusion



surgical treatment because the goal is to minimize pain. Postoperatively, most patients will engage in a treatment protocol involving home exercises and physical therapy. Therapists can help with scar desensitization, motion, and strength training. Working on strength training of the small muscles of the hand is just as important as exercising the larger muscle groups in the body. Small joint exercises may be tedious but formal therapy can result in better overall outcomes and improved patient satisfaction.

Risk factors

Repetitive movements, advanced age, family history, and hand trauma are just a few risk factors for hand arthritis. Osteoporosis can lead to degenerative changes in the body, including the hands; therefore, to maintain good bone health patients should have appropriate vitamin D and calcium levels. Researchers also believe that smoking cessation leads to better pain control and improved efficacy of corticosteroid injections. In terms of post-traumatic arthritis, the only way to minimize the risks are to minimize the dangerous activities that can result in such trauma but more so, to seek early medical attention. Following an injury, a patient should have an x-ray to determine the extent of injury or whether specialty care is needed. Fractures that are missed and diagnosed weeks or months later can result in significant disability.

See a hand specialist

Arthritis is only one of many reasons you may be experiencing hand pain. Managing symptoms may help to avoid invasive procedures and eliminate the need for surgical treatment. If you do find yourself requiring treatment, research your local or regional fellowship-trained hand surgeon for the best care.

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