Hughston Health Alert

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Inside...

Flexed (bent) knee shown with a total knee implant.

Not to scale

Mako SmartRobotics™ surgical system shown with a surgical plan below. Images provided by Stryker®

Fig. 1. A total knee surgery shown with the assistance of a Mako SmartRobotics™ surgical system.

Robotic Total Knee Replacement

QUESTIONS FOR A SPECIALIST

Technology is an ever-evolving part of our world. It seems to be integrated into almost every facet of our life—from cell phones, to travel, to our abilities to work from home, and of course, in our healthcare. Orthopaedics seems to be at the forefront as revolutionary leaps forward continue to fuel the advancement of medicine. The incredible progress visible to even the most untrained eye is astounding when it comes to knee replacement surgery.

A German surgeon, who inserted a hinged-iron joint in 1860, performed the first version of a total knee replacement. That first procedure initiated an evolution of knee replacements, and in the 160-year span, the procedure has undergone numerous reiterations with constant improvement. Nevertheless, it seems that just recently, the ability to incorporate computers and robotics has proven its worth.

What is robotic-assisted surgery?

Now when we speak of robotic knee replacement, we need to clear up the actual verbiage. More appropriately, it is a robotic-assisted knee replacement. This simply means that the robot is a tool that surgeons can use to perform a more precise and reproducible surgical procedure. The robot CANNOT and WILL NOT do the surgery without the surgeon. The surgeon is still entirely responsible for the patient and the procedure. In fact, the first 10 minutes or so in the operating room is routine exposure performed by the surgeon and assistants without the robot at bedside. However, once the time comes, the robot then provides invaluable information and technology to help the surgeon perform the procedure.

There are several different variations of robots available for assisting surgeons in total knee replacements. These range from passive systems, which provide information to the surgical team without assisting in the technical aspects of the case; active systems, which have the ability to perform tasks autonomously; and semi-active systems, which actively participate in the surgical procedure with the guidance of the surgeon in charge. My personal experience and preference is using the Mako Smartrobotics™ surgical system, which is in the category of robotic-arm-assisted technology. This system has been in use since 2005. It plays a role in hip replacements, partial knee replacements, and total knee replacements.

In order for a surgeon to be eligible to incorporate this skill into their practice, there is additional required training followed by proctored cases by a Mako Smartrobotics™ certified surgeon. Once integrated into a surgeon's practice, there is a misconception that there may be additional fees or time associated with the procedure. Typically, the use of a robotic system does not incur any additional cost to the patient or their insurance. The robotic assistance has actually improved surgical times by helping to ensure more precise implant position the first time with a dramatically lower rate of needing alterations in cuts. This is likely due to the incredibly accurate planning the system performs prior to initiating any bone cuts.

Why do surgeons perform robotic-assisted surgery?

So why would a surgeon change their practice and do more than the required training for a surgery that does not make any more money? I have personally participated in hundreds of knee replacements during my training using a tried and true traditional method. A method that does not rely on robotics, was very reproducible, and has good outcomes. However, once I established my own practice in Tennessee, I obtained Mako Smartrobotics™ training for numerous, well-considered reasons. First, this procedure has a growing body of publications supporting its effectiveness. The Mako Smartrobotics™ has the ability to improve accuracy and reproducibility in terms of bone cuts and implant placement. Ideally, with long-term data we hope to see this translate to better survivorship. A unique feature of the robotic-assisted technology robotic system is that it has protective boundaries. This means that while the surgeon is using the robot to very precisely complete bone cuts—accurate within 1 mm of planned—the saw which is held by the surgeon, but attached to the robotic arm, does not allow cutting outside of the preplanned area (**Fig. 2**). This advantage decreases the risk of injury to surrounding soft tissues, such as the vital posterior neurovascular (nerves and blood vessels) structures when compared to nonrobotic surgery. There is also some evidence showing

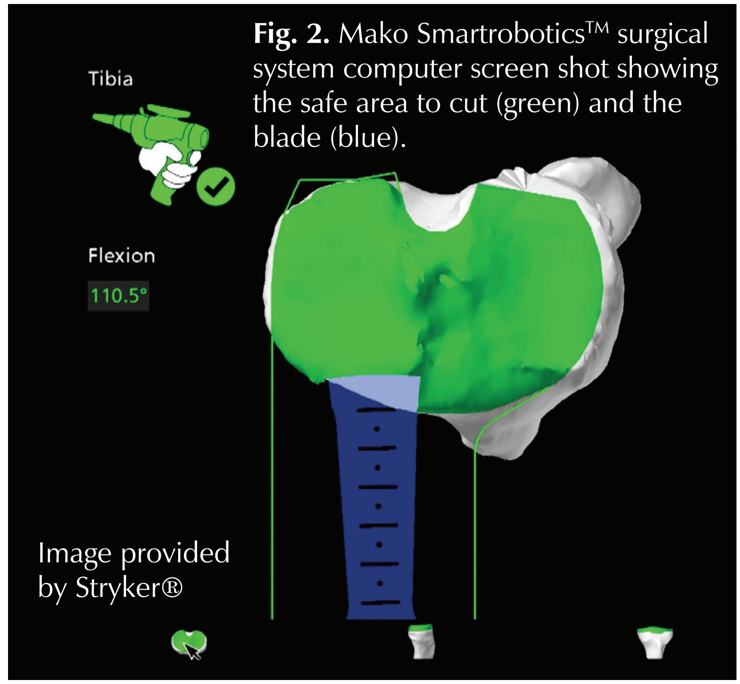


Fig. 2. Mako Smartrobotics™ surgical system computer screen shot showing the safe area to cut (green) and the blade (blue).

decreased postoperative pain and improved patient satisfaction scores with Mako Smartrobotics™ assisted knee replacement when compared with traditional, nonrobotic knee replacements.

Talking with my doctor

There are many ways to address knee arthritis; therefore, surgery is chosen once other treatment options no longer provide satisfactory relief. I also advocate that bad x-rays alone are never a reason to proceed with a knee replacement. Surgeons are not in the business of treating x-rays. Instead, we treat the person, not the picture. Once the doctor makes a diagnosis of arthritis, the severity of symptoms outweigh the severity of x-ray findings. The decision for a knee replacement should be made once a patient is personally, professionally, medically, and mentally ready to undergo this surgery. After the decision for surgery is made, we acquire insurance authorization, which is typically not an issue and no more difficult to obtain than if performing a traditional knee replacement.

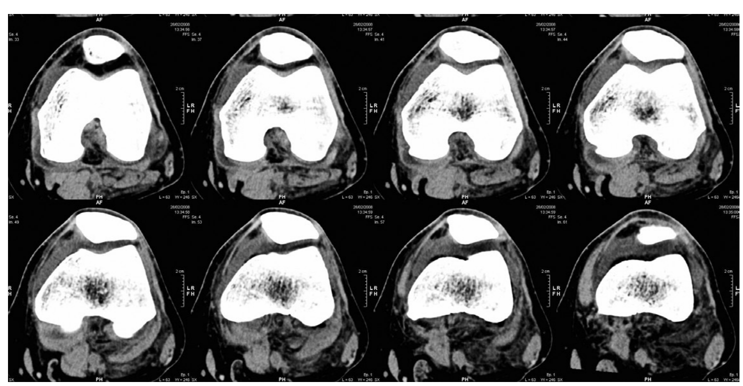


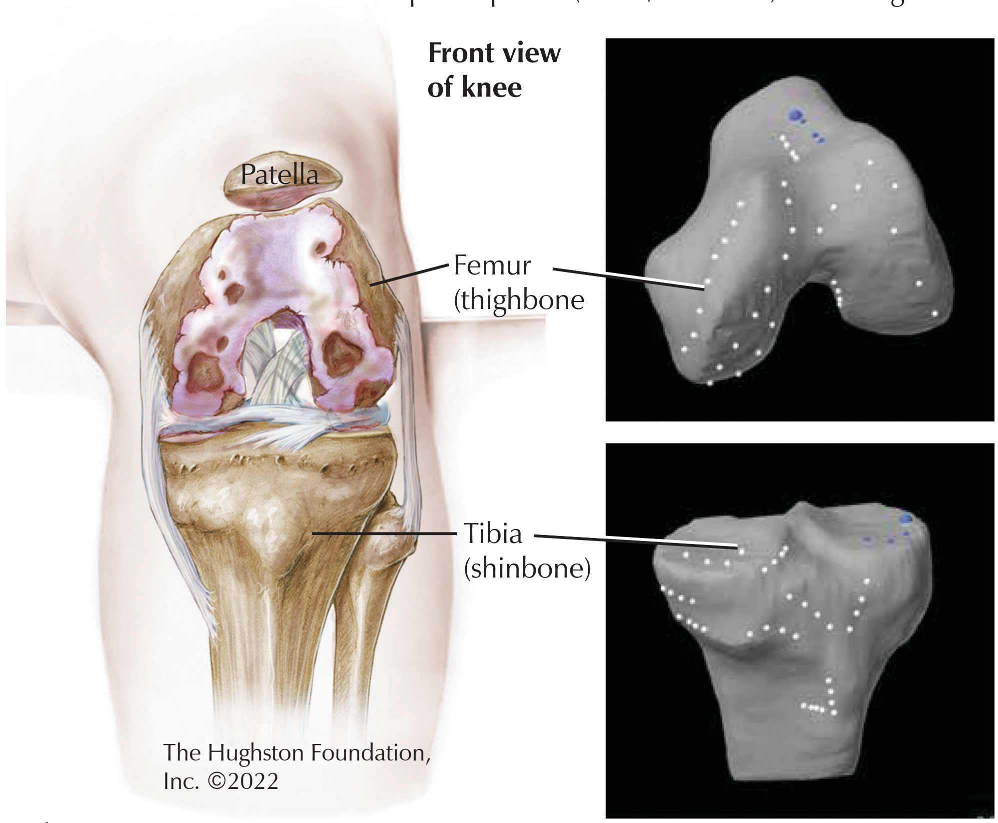
Image provided by Stryker®

Fig. 3. Computed axial tomography study (CT) scan of the knee taken prior to surgery to assist with surgical planning.

How is the procedure performed?

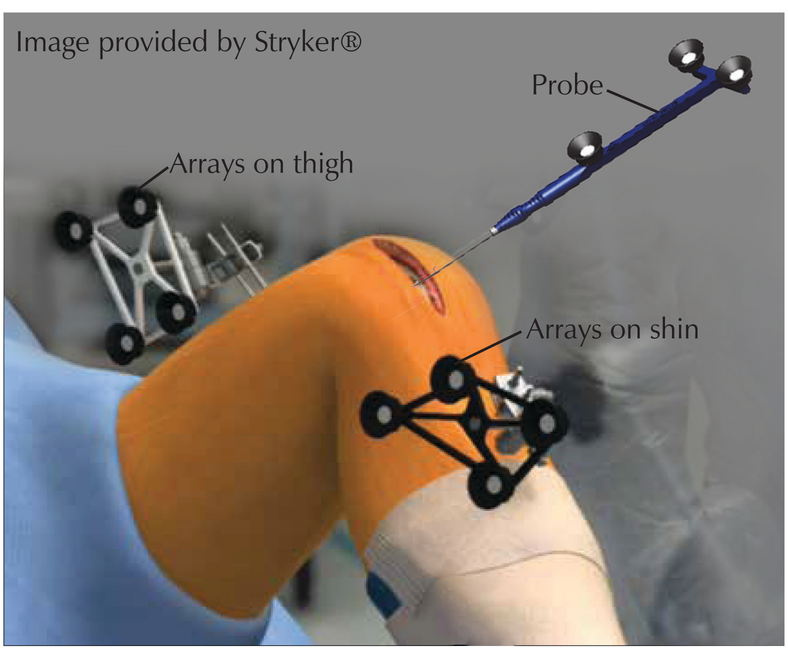
Preoperatively, the patient obtains a computed axial tomography study (CT) scan from hip to ankle, which includes the knee (**Fig. 3**). The scan provides a 3D reconstruction of the knee itself for planning purposes and it determines the perfect mechanical axis—an imaginary line that lies between the center of the hip to the center of the ankle, and which the center of the knee passes through. This is the basis of establishing robotic-assisted knee replacement surgical planning. Then, once the patient is in the operating room, the surgeons makes the routine exposure and surgical approach to the knee. Then the surgeon attaches arrays to the patient's leg (**Fig. 4**). Arrays are small reflective disks that the robot can closely track to follow leg position. Next, is registration where dozens of points within the exposed knee are touched with a special probe in order to correlate the anatomy found intra-operatively with the CT findings so that the robot now knows precisely how and where the knee is located (**Fig. 5**). Now, the surgeon removes any large bone spurs and manipulates the knee to as close to straight as possible. The Mako Smartrobotics™ system can now formulate the planned cuts (**Fig. 6 -** next page). The surgical team brings in the robotic arm and the surgeon uses a saw attached to the robotic arm to make incredibly precise cuts (**Fig. 2**). Once cuts are complete, the remainder of the tissues are prepared, the surgeon inserts the new knee components, and the wound is closed.

Fig. 5. Illustration of an arthritic knee on the left and the computer screen shots of the probe points (white/blue dots) on the right.



Images provided by Stryker®

Fig. 4. Lab simulation showing how the arrays would attach to the patients leg and the probe registers the points of reference.



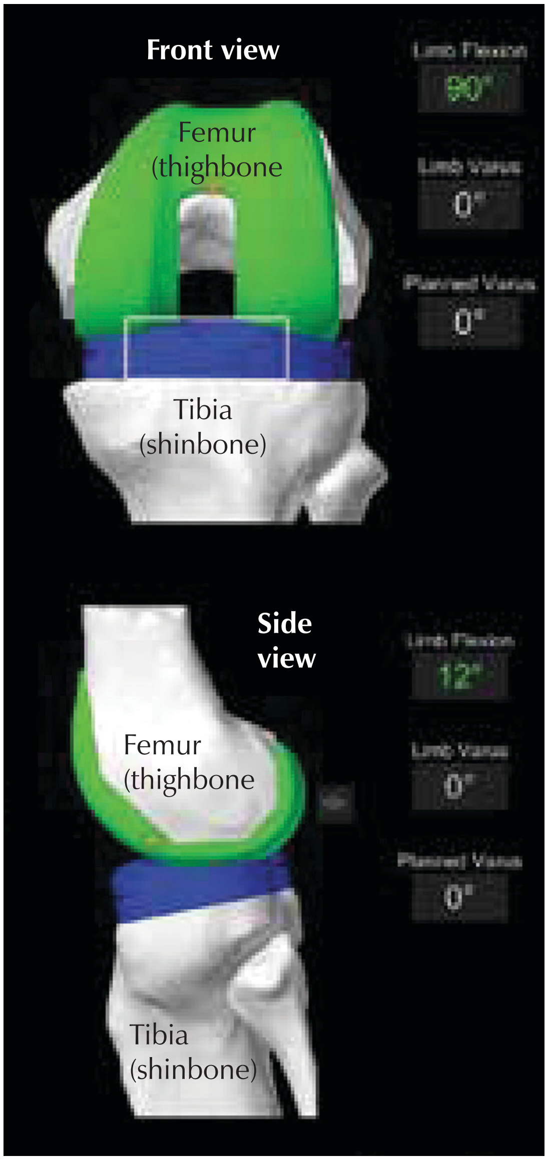
After surgery

Physical therapy begins as soon as possible. The patient may fully bear weight and immediately move the knee. Most patients can return home the same day as surgery. Although the surgical technique is obviously important, the postoperative therapy and hard work by the patient is equally as important. Physicians encourage therapy early and often, because most of the motion that a patient obtains for the remainder of their life is gained in the first 8 weeks after surgery. Although full weightbearing and motion is permitted immediately after surgery, often patients ambulate with a walker for about 2 weeks and then transition to a cane for an additional few weeks.

My recommendation

I have been using robotic-assisted technology for almost 9 years and I do not foresee myself ever returning to traditional methods. In my opinion, it has afforded me the opportunity to do a better surgery in less time with a better recovery for my patients. Due to our experience with this technology, we have patients

Fig. 5. Computer screen shots of the planned surgical cuts (green areas).



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from many distant regions traveling for this technology and our expertise with it.

Something I strongly suggest to every patient is to ask their surgeon, "What would you do if it were your family?" Well, my own father and aunt have driven over 5 hours to have their knee surgeries completed as outpatients using the Mako Smartrobotics™ upon my recommendation. Therefore, I am happy to advocate the same to all patients willing to consider this advanced technology for their impending knee replacements.

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3D-Printing in Cervical Spine Surgery

Over the past 2 decades, 3D-printing has emerged as an exciting and powerful technological advancement in various medical fields. This rapidly evolving field of study has enabled researchers to fabricate previously impossible materials into specialized shapes and forms. In tissue engineering, 3D-printing offers a great deal of control and the ability to create complex architectures for use as tissue scaffolds. Scientists conducting laboratory research have found that this new implant technology can promote a cellular response and initiate bone healing. In orthopaedics, implant technology is changing the way surgeons are treating patients with musculoskeletal disorders and injuries, in particular, those affecting the cervical spine (neck).

Spinal implants

Laboratory data have demonstrated that 3D computer printing can produce spinal implant materials that have bioactive properties, which can enhance the regenerative process. For example, researchers have designed spinal spacers with a porous structure that signals nearby cells to grow bone and allow bone cells to grow into and through the spacer implant (**Fig. 1**). In early clinical studies, 3D-printed spacers have demonstrated improved fusion and better clinical outcomes compared to spacers made of plastic or metal.

Physicians treat most degenerative conditions of the cervical spine successfully by nonoperative means involving therapy and medications. However, progressive neurologic deficits with persistent, painful symptoms lasting more than 6 to 8 weeks are often indications for surgical treatment (**Fig. 2**). For example, stenosis (narrowing) of the spinal canal can cause chronic pain, numbness, and muscle weakness in the arms or legs. To resolve these symptoms, a spine surgeon can perform a laminectomy (decompression surgery) by taking out a small piece of the vertebrae, called the lamina, and by removing any disc fragments or bone spurs that have applied pressure

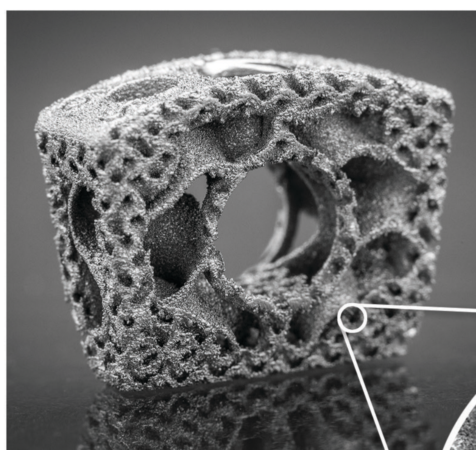

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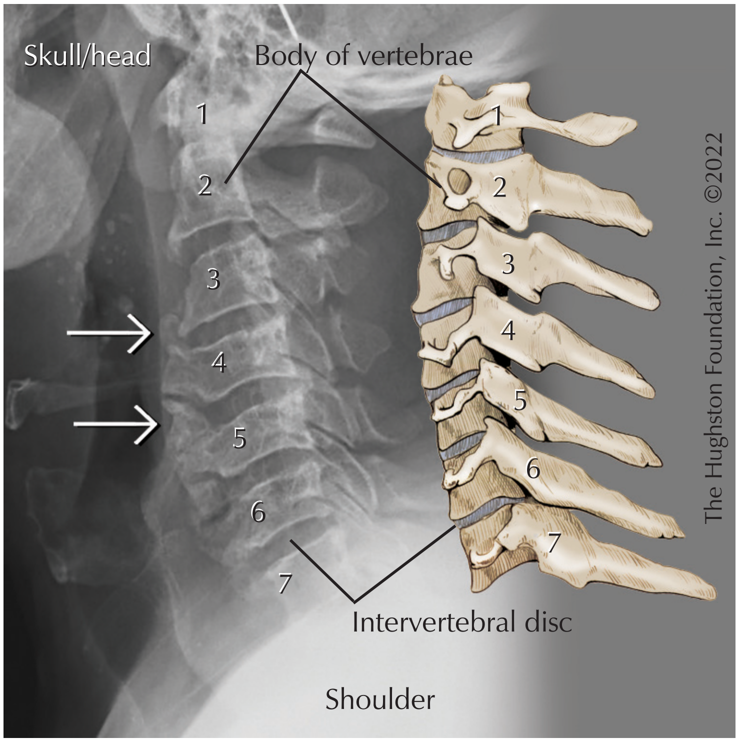
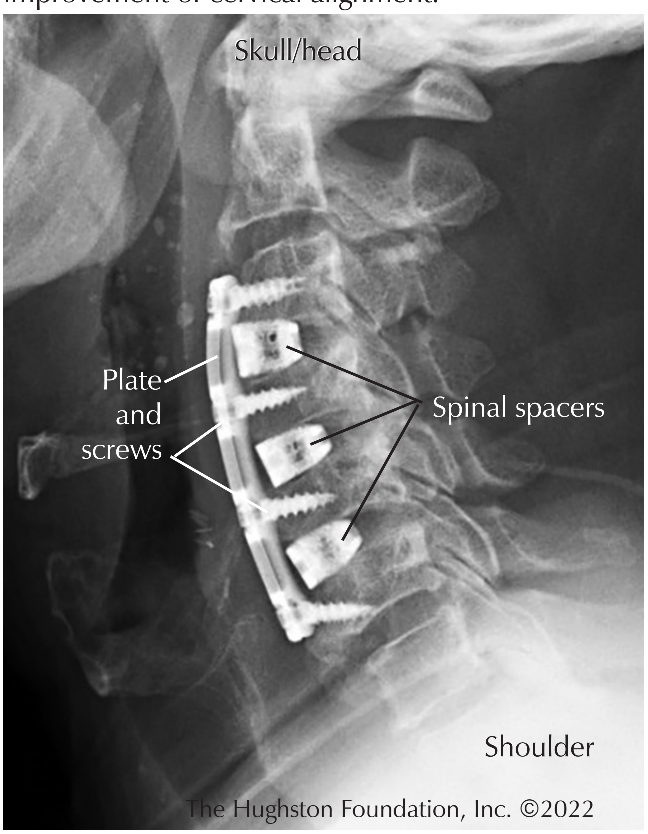
Fig. 1. 3D printed spinal cage with area enlarged to show the porus structure which allows bone cells to grow into and through the cage implant.



Fig, 2. Lateral (side) cervical spine (neck) radiograph shows multi-level bone spurs (arrows) and loss of normal spinal alignment. For comparison a normal cervical spine (7 vertebrae) illustration on the right hand side.

Fig. 3. Three months following surgery, lateral (side) cervical spine (neck) radiograph shows removal of bone spurs, progressing bone fusion crossing each surgical level cage, and improvement of cervical alignment.



to the spinal cord or nerves. The goals of the surgery are to enlarge the spinal canal for the spinal cord and nerves to pass, to re-establish normal disc space height, and to improve spine curvature. The surgeon may also perform an interbody fusion during the cervical decompression to provide permanent stabilization of lordosis (curvature) and disc space height. A successful clinical outcome is achievement of a solid fusion between the 2 vertebrae.

Spinal fusion

A spinal fusion is a surgical process that involves creating new bone formation across a spinal disc space (**Fig. 3**). Fusion in the spine is a complex process and the disc space is a challenging healing environment. In spinal fusions, interbody spacers are used in the disc space to unite 2 vertebrae together. The spacers serve a variety of purposes; they provide fixation, preserve the height of the disc space achieved during surgery, and encourage the bone graft to grow from one vertebral body into to the adjacent vertebral body. Surgeons use a bone graft to support the fusion process and provide elements to support bone growth. This fusion process is a race between resorption of the graft material and the formation of new bone, which grows through the graft to connect the 2 vertebral bodies. A successful interbody fusion induces new bone formation that bridges the disc space in order to help support viable bone.

Surgeons are using state-of-the-art 3D-printed spacers to attempt to win the race between resorption and the formation of new bone. Some research studies and case reports of patients who have undergone anterior cervical discectomy and fusion using an FDA-approved 3D-printed spacer device have reported good outcomes. Following surgery, the patients reported improved neurologic function, less pain, and improved physical outcomes, and at 3 months following surgery, radiographs demonstrated fusion progress across each disc space with bony ingrowth. Additionally, there were no instances of hardware failure or migration of the implant. Spinal alignment was similarly improved and maintained.

Good results

Although 3D-printing is still in the early stages of development for cervical implant surgery, the safety and efficacy of the technology is steadily emerging. One benefit researchers are finding comes from using the patient's anatomy to design the device. Since the device is custom-made, surgeons are able to preserve anatomy by removing less surrounding structures. Preserving anatomy can lead to shorter operative times, a better fit of the implant, and improved stability. The research thus far suggests that in the treatment of degenerative disc disease, unique 3D-printed interbody devices are safe and present a suitable alternative for successful outcomes in anterior cervical spine surgery.

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Ganglion Cysts

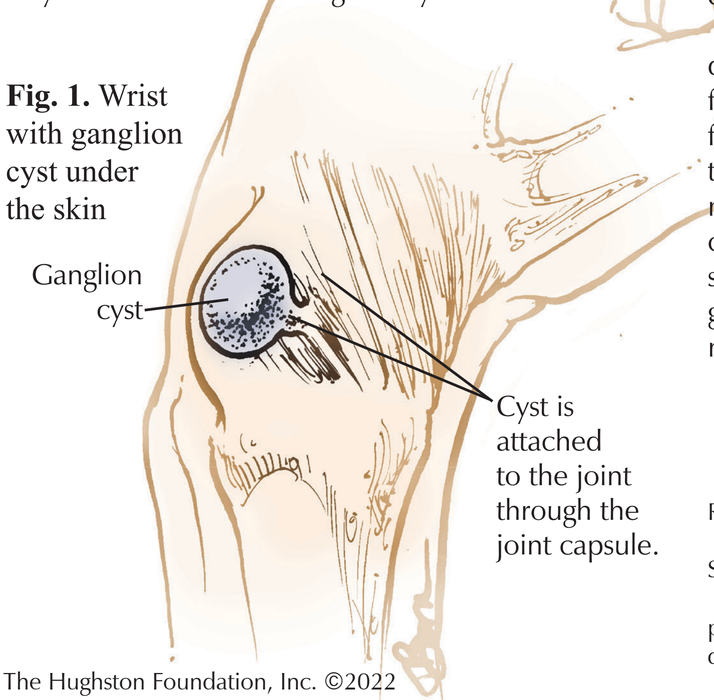
Ganglion cysts, sometimes called Bible cysts or Bible bumps (**Box**), are fluid-filled masses that can cause pain and discomfort. They can be as small as a pea or as large as a golf ball. These cysts are noncancerous, can change in dimension and shape, and do not move. Although wrists, hands, and ankles are the most common sites, ganglion cysts can form at any major joint in your body.

> **Box.** Did you know?
>
> A ganglion cyst was once called a Bible cyst because the at-home treatment was to smash it with a book. Since the largest and most commonly found book in the home was a Bible, they were called Bible cysts. Fortunately, today there are far less painful and much more effective ways to treat ganglion cysts.

How do I know I have a ganglion cyst?

Typically, ganglion cysts are round and form over the wrist. If you press on the mass, it can feel soft or firm and it moves very little. Inside the cyst is a thick, sticky, clear jellylike fluid. On the outside, the color of the cyst blends in with the surrounding skin. If it is small enough, it can go unnoticed for months or years before it becomes bothersome; however, if the ganglion cyst is near a nerve, pressure-causing pain, numbness, and even muscle weakness can result. The swelling can appear over time or suddenly and it may shrink in size or even go away and come back.

Fig. 1. Wrist with ganglion cyst under the skin



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Why do they form?

Although the exact mechanism for how a ganglion cyst forms is not known, a likely reason is that they arise from the leakage of synovial fluid around a joint, which ultimately accumulates to form a ganglion cyst.[1] Synovial fluid is a thick, clear liquid that lubricates the joints in our body and helps them move smoothly. The fluid is held in place by a wall called the joint capsule. With repetitive microtrauma, the wall can begin to breakdown and the fluid escapes into the surrounding joint. As more and more fluid begins to accumulate, a ganglion cyst can start to grow. At first, the bump may not be noticeable or bothersome in the early stages. Once it starts to increase in size, the ganglion cyst can start putting pressure on the joint, potentially causing pain and reduced joint mobility.

What treatment options are available?

If a mass appears, you should seek early diagnosis and treatment, even if it is not bothering you. There are various options in the approach on managing a ganglion cyst. If the lump is small and does not cause any symptoms, your doctor may suggest watching and waiting before taking any medical intervention. It is estimated that up to 50% of ganglion cysts will resolve on their own without the need of medical assistance.[2] It can take several months before the mass decreases in size.

If the cyst begins to grow or starts to become painful and troublesome, medical intervention can help. Your doctor may recommend the use of a brace or splint to immobilize the affected area. This prevents further microtrauma to the wall of the joint capsule and stops more fluid from accumulating. Your physician may aspirate the cyst, using a needle to remove the excess fluid from the mass. Although the procedure reduces the size of the cyst immediately, it is not a definitive treatment because a ganglion cyst treated in this manner may recur. If nonsurgical treatments have failed or the mass returns, your doctor may recommend surgery.

Typically, your doctor will recommend surgery if aspiration did not help, if the mass is painful and interferes with your daily functions, or if it causes tingling or numbness in the hands or fingers. A surgeon can remove the cyst and the surrounding tissue that attaches it to the joint on an outpatient basis with minimal complications. Although rare, complications include continued pain even after surgical removal, weakness to the surrounding joint, and recurrence. If you believe you have a ganglion cyst, consult with your doctor for proper diagnosis and management.

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Toxic Shock Syndrome:

A MEDICAL EMERGENCY

Toxic shock syndrome (TSS) is a rare and often life-threatening illness that develops suddenly after a bacterial infection. It can affect different organ systems, including the kidneys, lungs, and liver causing multiple organ failure. TSS progresses quickly; therefore, immediate medical treatment is needed.

Causes

TSS is caused by the body's sudden and massive immune response to toxin-producing strains of gram-positive bacteria—Staphylococcus aureus and Streptococcus pyogenes (group A streptococcus). These toxins that act as superantigens over stimulate a normal immune-cell response and overwhelm the body's normal functions. A patient's symptoms can mimic other illnesses, but with TSS, these symptoms can worsen rapidly (**Box**). Symptoms often include a high fever, vomiting, diarrhea, a sunburn-like rash, and signs include low blood pressure and shock including confusion, dizziness, or fainting. During orthopaedic surgery, the acute onset of TSS is rare; however, due to the serious nature of this disease, it is important for surgeons to recognize it to begin immediate treatment.

Risk factors

TSS can affect men, children, and women of all ages; however, about half of all patients with staphylococci bacteria occur in women of menstruating age. Risk factors for TSS include skin wounds, surgery, and the use of tampons and other devices, such as menstrual cups, contraceptive sponges, or diaphragms. Additionally, TSS is associated with infections, for example cellulitis (bacterial skin infection), pneumonia (viral or bacterial lung infection), or osteomyelitis (bacterial bone infection). It is also important to note that if you have had TSS before, you should discuss this with your physician or surgeon before you receive any medical treatment. People who have had TSS before are at a higher risk of it getting it again.

Osteomyelitis and TSS

In orthopaedics, long bone infections and chronic osteomyelitis are common diagnoses. The number of bony infections relates to the prevalence and severity of injuries, particularly due to motor-vehicle accidents. The treatment of open extremity injuries or established infections in long bone fractures usually involves a prolonged course of antibiotics, wound debridement (removal of damaged tissue), and fracture stabilization.

TSS has been associated with a variety of surgical procedures and with postoperative abscesses. The source of infection is commonly acquired at or near the time of surgery and has been described following nasal packing, insertion of hardware, surgical drains, and retained foreign materials.

Box. Toxic Shock Syndrome Symptoms

- A sudden high fever of 102°
- Fainting
- Rapid drop in blood pressure
- Confusion
- Diarrhea
- Fatigue
- Headache
- Low urine output
- Overall muscle pain
- Red eyes
- Seizures
- Sunburn-like rash on your palms and soles
- Thirst
- Vomiting
- Weakness or lethargy

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Diagnosis

There is no single test for TSS and doctors often diagnose it in an emergency setting. Your doctor will order blood and urine samples to test for the presence of a staph or strep infection. For a female patient, the doctor may also order swab testing of the vagina, cervix, and throat for the presence of the bacteria. Since TSS can affect your organs, the doctor may order a CT scan, a lumbar puncture to test spinal fluid for bacteria, or a chest x-ray to assess the extent of your illness.

Treatment

Patients with TSS are often hospitalized, sometimes in the intensive care unit, and treated with antibiotics, while doctors seek the source of the infection. While in the hospital, you will receive care for your other symptoms, such as stabilizing your blood pressure, reducing your fever, and pain medicine for muscle aches and headaches. Additionally, the toxins produced by the bacteria and accompanying hypotension can cause kidney failure. If that happens, you may need dialysis.

A medical emergency

Call your doctor or surgeon immediately if you experience any symptoms of TSS, especially if you have recently had surgery or a skin or wound infection. TSS is a medical emergency that cannot be treated at home. It can progress rapidly, causing serious complications such as shock and renal (kidney) failure, and even death.

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