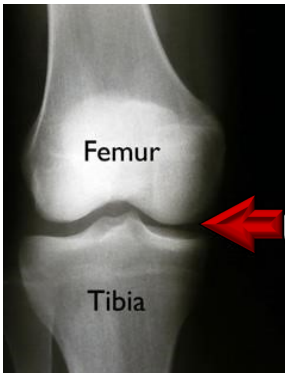
Robotic technology improves accuracy in joint replacement surgery

by Taylor Patton, ATC

Chances are you know people who have had knee arthroplasty (replacement) surgery, or perhaps you're considering the surgery. While joint replacement surgery is performed regularly before 1974 there was no procedure for patients with debilitating knee arthritis except ice, pain medication and rest. However, technology and innovation have changed making knee replacement surgery one of the most performed procedures in the world and the only cure for advanced knee arthritis.



X-ray of knee with normal joint space and healthy cartilage.

X-ray of knee shows loss of joint space from compressed or missing cartilage causing arthritis.

Total knee arthroplasty (TKA) is indicated generally recommended for people with symptomatic knee arthritis who failed conservative treatment. Knee arthritis is the painful and limiting condition that results from the structural loss of cartilage, the thin protective layer of firm but compressible tissue along the surface of the articulating (contacting) ends of our bones. TKA replaces the worn joint surface with a new artificial surface composed of metal and high molecular-weight polyethylene plastic.

A prototype of the first orthopaedic robot, ROBODOC, on display at the Smithsonian's National Museum of American History.

Aside from relieving severe knee pain, knee replacement surgery helps patients return to a functional ambulatory status which has an overall positive impact on the patient's general health and their quality of life. Studies on long-term survivorship for knee arthroplasty can be close to a 100 percent at 10 years and remains just greater than 80 percent at 25 years. Despite this promising data, not all patients obtain a satisfactory outcome. New technology, materials and designs continue to push forward for better results and outcomes.

One innovation—the robotic-arm assisted surgical procedure—is becoming increasingly more common especially in orthopaedics. In fact, according to the Smithsonian's National Museum of American History, robotics have been used in orthopaedic surgery in the United States since 1992 with the introduction of ROBODOC a surgical robot developed for planning and performing total hip replacements. Since then, the use of robotic technology has expanded and today includes spine, total joint arthroplasty, trauma, shoulder, and foot and ankle orthopedic subspecialties.

There are many advantages to using robotic technology and computer navigation for orthopaedic surgery including helping the surgeon precisely position the implants to replicate the original anatomy location as close as possible, balance and adjust

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Robotic surgery

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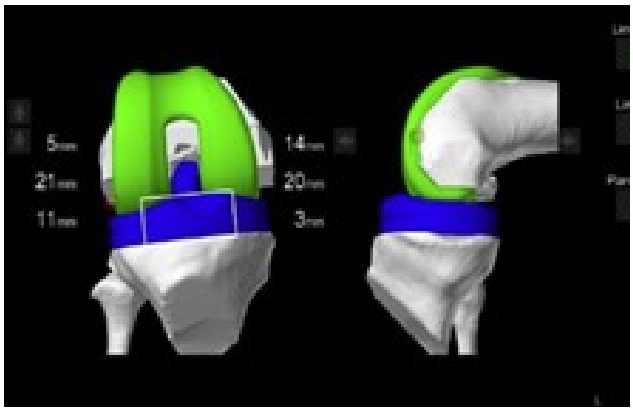
the knee ligament tension to allow for normal kinematics (motion), minimize surgical trauma, provide better access to difficult anatomic areas, decrease X-ray use, and potentially reduce complications.



Prior to beginning the knee replacement surgery, Dr. Steven Chudik places markers and arrays (special wireless navigation instruments) that tell the computer and robot the exact position and coordinates of the knee and projects 3-D images on a screen to guide Dr. Chudik during surgery.

Dr. Steven Chudik, orthopaedic surgeon, sports medicine specialist and founder of Orthopaedic Surgery and Sports Medicine Teaching and Research Foundation (OTRF), uses the latest, state-of-the-art computer navigation technology with robot-arm assistance to perform joint replacement surgery. The computer navigation allows Dr. Chudik to plan and virtually perform the surgery on the computer even before making an incision. Prior to scheduling surgery, patients have a special computerized tomographic (CT) scan of the knee. The highly accurate, anatomic CT scan data is loaded into a computer and processed with special software to create a preliminary surgical plan. The computer plan is so detailed Dr. Chudik can position implant images on the plan to pre-determine the optimal size, position and alignment of prosthetic implants. According to Dr. Chudik, the closer I can position the implant to my patient's native joint location, the better the recovery and outcome will be.

Once the virtual procedure on the computer is complete, Dr. Chudik makes a small incision and exposure in the patient's knee—considerably smaller than he would if performing conventional open or minimally-invasive, non-assisted surgery. Inside the incision, he places markers and arrays (special wireless navigation instruments) that tell the computer and robot the exact position and coordinates of the knee. The computer-navigated robotic system is so precise and responsive, it can track and move with the leg in real time.

After exposing the knee and placing the navigation instruments, Dr. Chudik moves the actual knee through a wide range of motion and stresses the ligaments. The computer-navigated robotic system tracks these movements and allows Dr. Chudik to virtually adjust the implant positions on the computer to correctly balance the knee ligaments and allow proper movement of the knee. After determining the optimal position and alignment of the implants and the knee, Dr. Chudik drives the computer-navigated robotic arm and its cutting instrument to precisely prepare the worn arthritic surfaces of the knee—just as it was virtually performed on the computer. The computer-navigated robotic arm is controlled by Dr. Chudik, but it possesses safe boundaries and controls allowing him to make the perfect cut every time.

After preparing the joint surface, Dr. Chudik temporarily places trial prosthetic implants in place and moves the knee while feeling the leg and watching it on the computer screen to the ensure that proper

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