

Robotic Arm, Smart Knee, X-Ray Vision

Innovative Technologies in Orthopedic Surgery

By Robin Frank



Dr. Jonathan Vigdorichik

Lending a Hand: A Robotic Arm and Computer Navigation

In spine surgery, surgical robots, advanced imaging technology and computer-assisted navigation provide enhanced precision, accuracy and predictability, according to Dr. James Dowdell, a spine surgeon at Hospital for Special Surgery (HSS) in New York City and at HSS Paramus.

Detailed images of a patient's anatomy are obtained to plan and customize the procedure prior to surgery. CT and MRI scans create a three-dimensional map of the patient's spine, and a computer console displays the high-definition 3D image in real time during surgery. The orthopedic surgeon uses a robotic arm for guidance, always maintaining full control.

"The system enables the surgeon to make very small incisions that preserve muscles and other structures surround-

Technology is a wonderful thing when it can help us complete tasks more efficiently, enhance communication and learning, and make our lives better. In the field of medicine, technological advances lead to new and better treatments, more personalized care, increased efficiency and improvements in safety.

Such innovations have been a boon to orthopedic surgery, as engineers, scientists and inventors design systems to improve accuracy and safety in the operating room. As technologies evolve and studies demonstrate the benefits, increasing numbers of orthopedic surgeons are using robotics, computer navigation, augmented reality and smart sensors to improve patient care.

ing the spine, so patients generally experience less pain after surgery, a shorter hospital stay and a quicker return to activities compared to traditional open surgery," Dr. Dowdell says.

The technologies are especially useful for more challenging cases—patients whose anatomy differs from the norm—according to Dr. Gbolabo Sokunbi, a spine surgeon at the HSS Paramus and Saddle River locations and at the main hospital in New York City. Dr. Sokunbi advises anyone considering spine surgery to carefully check the physician's credentials and choose a hospital in which a high number of spine surgeries are performed. He notes that a good rapport with the treating physician, good communication and trust are also essential.

Robotic assistance and computer navigation are also major players in joint replacement surgery. Their use has been growing exponentially as increasing numbers of hospitals acquire the technology. The robotic systems allow for the optimal alignment, soft tissue balancing and positioning of the implant—critical to the long-term success of a hip or knee replacement.

Seeing Is Believing: The Use of Augmented Reality in Surgery

An orthopedic surgeon at HSS performed the first knee replacement using augmented reality (AR) in the United States in 2020. AR refers to digital content, such as a 3D image, that is superimposed on a user's view of the physical environment. An example would be a design app that allows you to visualize a 3D model of furniture or décor in your home before you buy it.

It starts with a CT scan to create a 3D model of the patient's knee to plan and customize the procedure. During surgery, the use of augmented reality smart glasses allows the orthopedic surgeon to visualize the structures of the knee under the skin and track progress in real time directly on the operative field, without having to look over at a computer screen. It has been likened to giving a surgeon "x-ray vision."

"It's like a car that has the speedometer projected on the windshield, so you don't have to look down when you're driving," says Dr. Jonathan Vigdorichik,



the hip and knee surgeon who performed the first procedure at HSS. Taking the car analogy one step further, he compares the AR knee replacement platform to GPS. “Everyone knows how to drive home, but you use GPS technology to find the best and most efficient route to take,” he says. Dr. Vigdorich notes that the augmented reality platform allows for an ultraprecise surgery.

More recently, HSS spine surgeons have also begun to use augmented reality technology. The spine system consists of a headset and the elements of a traditional computer navigation system. During surgery, it accurately determines the position of surgical instruments in real time and superimposes them on the patient’s CT scan.

“The technology allows us to visualize the patient’s 3D spinal anatomy during surgery to accurately guide instruments and place surgical implants, such as pedicle screws, while looking directly at the patient rather than at a separate computer screen,” explains Dr. Frank Cammisa, chief emeritus of HSS Spine. “Improved control and visualization of the patient’s anatomy and critical structures can lead to a more precise, efficient surgery and can enhance safety.”

“Smart Knee” for Remote Patient Monitoring

Imagine knee replacement surgery with a “smart” implant that collects and transmits data enabling an orthopedic surgeon to monitor a patient’s recovery from afar. It became a reality in 2021 when orthopedic surgeons at HSS performed the first knee replacement containing a smart sensor capable of measuring steps taken, walking speed, range of motion and other indicators of knee function following surgery.

An innovation in the growing field of remote patient monitoring, it was the first implantable device approved to collect data on an individual’s progress after a knee replacement. Although the technology does not preclude office visits altogether, it enables the doctor to actively monitor a patient’s recovery with real-world, objective data to supplement his or her care.

The smart knee contains a sensor that is integrated into the joint replacement prosthesis. Once implanted, it records and wirelessly transmits information to a personal base station, about the size of a modem, that plugs into an outlet at the patient’s home. The data is then securely sent to a cloud-based platform where

the orthopedic surgeon can review it and check on the patient’s progress and recovery.

Remote monitoring can be especially useful during the early post-operative period, says Dr. Peter Sculco, who performed the first procedure at HSS. “In the first several weeks following knee replacement, hard work is required from the patient. The earlier you identify a patient who may not be progressing as well as you would like, the sooner you can intervene,” he explains.

“The smart knee uses the same material and technology found in implanted cardiac devices such as pacemakers,” adds Dr. Fred Cushner, a knee surgeon at HSS in Manhattan and Long Island. “It collects data every day during the first year following surgery, providing objective, accurate information on how the knee is functioning.”

The HSS experts agree that while hospitals and surgeons seek to remain competitive with the latest technology, they must never lose sight of the needs, goals and values of each individual patient. The latest and greatest technology will never replace evidence-based, respectful and compassionate care.