Robotic-Assisted Surgery with Twin Cities Spine Center

BY THOMAS CROCKER

TRUE TO **TWIN CITIES SPINE CENTER'S** MORE THAN 70-YEAR HISTORY OF ADVANCING SPINE CARE, ONE OF ITS SPINE SURGEONS RECENTLY BECAME THE FIRST IN THE TWIN CITIES TO USE MAZOR X, A ROBOTIC-ASSISTED SURGICAL SYSTEM THAT COMBINES PREOPERATIVE PLANNING AND INTRAOPERATIVE GUIDANCE TO HELP SURGEONS PERFORM OPERATIONS FOR INDIVIDUALS NEEDING SPINAL INSTRUMENTATION FOR FIXATION OR STABILIZATION.

FEATURING 11 SPINE SURGEONS, 15 physician assistants, a social worker, robust research department and renowned fellowship program that has trained more than 175 spine surgery fellows since 1971, Twin Cities Spine Center is internationally recognized for its team's expertise in treating degenerative spine diseases and deformities in patients of all ages. The practice's reputation is rooted in its willingness to embrace innovation to improve the safety and efficacy of treatment. The most recent manifestation of that occurred late last year at Allina Health's Abbott Northwestern Hospital, where spine surgeon Eiman Shafa, MD, Director of the Spinal Robotics Program at Twin Cities Spine Center, used Mazor X to perform the Twin Cities' first robotic spine surgery.

Mazor Robotics is an Israeli medical device company and manufacturer of the robotic guidance system for spine surgery, Mazor X. Mazor X features preoperative 3D imaging that allows spine surgeons to precisely tailor the type and placement of spinal instrumentation for patients with degenerative spine diseases, such as spinal stenosis, and other conditions, including spondylolisthesis and scoliosis.

"It's important to grow and utilize not just new technology but new technology that improves patient outcomes and satisfaction," Dr. Shafa noted. "Robotic surgery helps us adhere to our ideals of providing safer, less invasive surgeries. X-ray guidance and CT navigation have allowed us to perform percutaneous implantations of instrumentation in the past, but robotic technology allows us to be even more exact, to the submillimeter level. It also produces a more streamlined workflow because the surgeon is able to plan for instrumentation options before surgery. Intraoperatively, all the focus is on carrying out the plan."

LEARNING THE TERRAIN

Before or during surgery, the patient undergoes a CT scan of the relevant levels of the thoracic, lumbar or lumbosacral spine. Using the images, Mazor X software algorithms recognize the anatomy and define the segmentation of the spine. The surgeon confirms the accuracy of the software's work and creates a 3D surgical plan that includes the optimal instrumentation size and implantation trajectory for the patient's anatomy.

"If the patient underwent a CT scan prior to surgery, we take an intraoperative X-ray, and Mazor X performs image registration, meaning the software pairs the information from the X-ray with the CT scan," Dr. Shafa says. "That's one of the powerful things about Mazor X. The algorithm is able to truly take 2D X-ray images from different orthogonal views and reconcile it with the 3D CT scan. Once that's done, the computer knows where the patient is lying and where each segment of the spine is in space. Then, we can use the preoperative plan, which was created with a CT scan when the patient was supine, and implement it with the patient in a prone position for surgery."

OPERATING ACCORDING TO PLAN

During surgery, the second major component of Mazor X comes into play: its robotic surgical arm, which, far from performing the surgery, acts as a guiding mechanism to aid the surgeon in accurately placing the instrumentation.

"As the surgeon, I, not the robot, develop the surgical pathway, and place the tubes that provide a corridor through the muscle and fascia," Dr. Shafa says. "That way, I always receive the live feedback I'm used to and expect when performing the operation. I place the instrumentation by hand through this guided corridor while observing their progress into bone live on a monitor."

To Dr. Shafa, the marriage of preoperative planning and intraoperative navigation with the robotic arm is what sets Mazor X apart.

"The robotic arm brings me to the trajectory I need, and the navigation tells me where I am in space, in real time, which allows me to know whether I'm executing the plan I made," he says. "What Mazor X does — incorporate live navigation and preoperative planning — is one of the reasons Allina Health and Twin Cities Spine Center decided to adopt this system."

Meet Dr. Shafa

WHEN SPINE SURGEON Eiman Shafa, MD, joined **Twin Cities Spine Center** in 2017, he was no stranger to the practice: Just a year earlier, he had completed a spine surgery fellowship there. That marked the end of a medical education and training journey that began at Temple University in Philadelphia, where Dr. Shafa earned his medical degree. He went on to complete a residency in orthopedic surgery at Seton Hall University School of Health and Medical Sciences, St. Joseph's Regional Medical Center, in New Jersey, as well as training in orthopedic oncology at Mount Sinai Hospital and pediatric orthopedic surgery at Nemours/Alfred I. duPont Hospital for Children in Delaware.

Dr. Shafa joined Twin Cities Spine Center from a large orthopedics group in New Jersey. He specializes in treating conditions of the cervical, thoracic and lumbar spine, including spinal stenosis and other degenerative diseases, cervical diseases, scoliosis, spine deformities and trauma. He has specialized training in minimally invasive surgery, robotic surgery, disc arthroplasty and deformity correction.

"I joined Twin Cities Spine Center because it's the oldest and one of the best spine surgery training programs in the country, and I can be involved in meaningful research and training fellows here," Dr. Shafa says. "Being part of this practice helps me deliver the best all around care in spine surgery, including the most effective technologies."

Twin Cities Spine Center's emphasis on patient-focused quality assessment appeals to Dr. Shafa.

"We have established means of assessing not only how patients are doing with each procedure, but also to look at ourselves in depth and try to find ways to make our procedures safer and improve the overall experience for the patient," he says. "Being a high-performing center like ours is practically a prerequisite to being able to learn from the surgeries one performs."

A BEVY OF BENEFITS

According to Dr. Shafa, surgery using Mazor X offers appropriate patients a variety of benefits compared with conventional procedures, including:

+ Greater individualization — Every patient's spinal anatomy is different. The preoperative planning component of Mazor X allows the surgeon to individualize procedures by selecting the instrumentation and trajectory that best suit each patient's bone structure.

+ Improved accuracy — Thanks to the guidance of the robotic arm, the surgeon is able to place instrumentation with submillimeter precision. This may reduce complications associated with malpositioned implants, such as nerve compression or fracture, as well as the number of revision procedures required to fix them.

+ More streamlined workflow — With an operative plan in place before setting foot in the operating room, the surgeon has already decided how the surgery will proceed, and may result in shorter, more efficient operations.

+ Reduced radiation exposure — Preoperative planning reduces the need for X-rays during surgery, which is beneficial for the patient and everyone else in the operating room.

"The key benefit of Mazor X is ensuring I'm doing what I planned to do," Dr. Shafa says. "Instrumentation is a means to an end — it's only a portion of what I'm trying to accomplish. Making sure I implant the instrumentation without error allows me to know I have the best fixation I can get that will result in the least motion in the spine after surgery. The surgeon has to stabilize the spine to get it to fuse. The planning portion of Mazor X is powerful because when the surgery starts, I've already thought about it at length, and I know exactly where I'll be positioning each screw. With that, I can achieve the best correction."

Mazor X is not without limitations. It enables greater customization of spine surgery, but the uniqueness of some patients' spinal anatomy can foil its

"I strive to offer referring physicians and collaborating specialists a detailed plan of what I need to take care of and what I aim to accomplish with each patient. My lines of communication are always open, and I invite all physicians to get in touch with my office with any questions or concerns."

— EIMAN SHAFA, MD, SPINE SURGEON AND DIRECTOR OF THE SPINAL ROBOTICS PROGRAM AT TWIN CITIES SPINE CENTER

segmentation algorithm, according to Dr. Shafa. If, for example, two bones are fused, the algorithm — which bases its assessment on normal anatomy — may not be able to distinguish between the two.

"As with operating microscopes, the robotic arm is another piece of equipment with the potential for contamination in the operating field," Dr. Shafa says. "That's why we take a lot of precaution during the draping procedure. The limitations of Mazor X are why we don't want to be 100% reliant on it. As the surgeon, I still have to be able to perform every procedure I plan to undertake, whether I'm going to use the robotic system or not."

PROMISING EARLY RESULTS

Dr. Shafa and Benjamin Mueller, MD, PhD, at Twin Cities Spine Center have completed nearly 10 Mazor X procedures since late last year, all at Abbott Northwestern Hospital. All Twin Cities Spine Center surgeons have trained to use the system. Currently, the surgeons perform a small number of selected robotic procedures each month. Dr. Shafa believes that the number of surgeries that will benefit significantly from the use of the robotic system will increase to about 50 procedures per year.

"Our outcomes have been very positive, with no errors in the placement of instrumentation," Dr. Shafa says. "We've had good results in terms of expected relief of leg and back pain, and blood loss for all procedures has been low. We've also seen improvements in workflow."

Twin Cities Spine Center's biomechanics lab and vigorous clinical research arm make it well positioned to assess the results of its team's Mazor X procedures to ensure the technology delivers on its promise. The data Twin Cities Spine Center gathers provides a valuable knowledge base, as the practice hopes to share its experience with Mazor X with other facilities that adopt the system. Dr. Shafa also hopes to assess other potential applications of robotic–assisted surgery as they become available in the horizon.

AIMING TO SHAPE THE FUTURE

Dr. Shafa views his and Twin Cities Spine Center's role vis-à-vis Mazor X as twofold: to perform safe, beneficial procedures for patients and help point the way toward future applications for the robotic system by continuing the practice's rich tradition of conducting research. He thinks there is potential to incorporate Mazor X into other aspects of spine surgery, including decompression and correction of spinal deformities.

"Over the next year, my hope is to be able to look at our outcomes and really assess whether we're delivering a less invasive, more efficient surgery," Dr. Shafa says. "I hope, as we get more comfortable with Mazor X, we're able to help move the technology beyond simple instrumentation placement and incorporate it into other parts of spine surgery. That technology doesn't exist yet, but I hope Twin Cities Spine Center can be a driver for it."

In the meantime, Dr. Shafa and his colleagues plan to continue using conventional techniques along with other minimally invasive approaches, such as robotic-assisted surgery with Mazor X, to treat patients safely and efficaciously.

"Not every patient needs surgery or is a candidate for surgery using Mazor X," Dr. Shafa says. "Our philosophy is to render the least invasive treatment we can. Bringing on robotic technology aligns well with that approach. It gives us another option to ensure we do the right thing for our patients every time."

For more information about Twin Cities Spine Center's services, visit tcspine.com. ■