



Dale S. Horne, MD, PhD

ROBOTIC ASSISTANCE IN SPINE SURGERY

The implementation of surgical robots in the operating room has given surgeons in a number of specialties the advantage of increased accuracy while performing minimally invasive procedures. This means better localization of surgical targets with less damage to surrounding tissues and, ultimately, better outcomes. In spine surgery, a number of computer-assisted surgery (CAS) spinal navigation systems are commercially available that aid in the placement of spinal implants. These systems require “line of sight” between the tracking camera and surgical tool and accuracy is limited, in part, by the surgeon’s ability to freehand match the trajectory in three planes to the plan on the monitor. Since these systems are complicated and often increase surgical time, many surgeons have given up or avoided stereotactically placing implants.¹

SpineAssist (Mazor Robotics) takes stereotactic guidance to the next level by eliminating the line of sight constraint and freehand skills

of the surgeon and providing for a simpler and more consistent and accurate means of placing hardware while exposing patients to less X-ray radiation. What sets SpineAssist apart from conventional CAS techniques is that a robot, about the size of a soda can but capable of six degrees of freedom, is rigidly mounted to the patient, either on a spinous process clamp or on a platform secured to the posterior superior iliac spines (PSIS) and a spinous process (Figure 1). As the robot moves, it guides an arm to a fixed location that provides the preplanned trajectory and entry point without requiring anatomic visibility. Although a main focus of the robot is for the placement of pedicle screws, the system is also able to place facet screws, translaminar screws and translaminar facet screws, and has been used in Europe for vertebroplasties, kyphoplasties and biopsies and to place Guided Oblique Lumbar Interbody Fusion (GOLIF) screws. This ability to target easily, accurately and efficiently allows the surgeon to

perform minimally invasive or open procedures in a wide range of patients and is especially useful in degenerative spine procedures, spinal deformity cases, patients with anatomically small pedicles (Figure 2), thoracolumbar fracture stabilization, and patients with elevated BMI. The SpineAssist is FDA approved and is currently in clinical use in multiple centers around the world including the US.

The flow of a SpineAssist case is straightforward. Each patient receives a preoperative CT scan in Digital Imaging and Communications in Medicine (DICOM) format at the time of preadmission testing. In our facility these images are loaded to a virtual drive accessible over the internet from a virtual private network. The scan is then loaded into the proprietary planning software on a PC or Mac running Microsoft Windows. The program reconstructs the raw CT data into three-dimensional virtual X-rays for each individual vertebra in the region of interest.¹ In the operating room on the day of surgery, the surgeon mounts the SpineAssist platform to the patient, either a clamp on a spinous process for short segment cases, or the Hover-T frame to the PSIS and a spinous process in long segment cases. Two intraoperative fluoroscopic images are acquired, one in the anterior-posterior (AP) plane and one 600-oblique plane, using a registration device mounted to both the image intensifier and SpineAssist platform. These images are used to create a segmental registration match of each vertebra to the virtual X-ray images from the preoperative CT plan. The system has several checkpoints along the registration process to ensure accuracy.

Once the registration device is exchanged for the robot on the SpineAssist platform, the surgeon chooses the vertebral body and side of the patient to begin placing screws. The

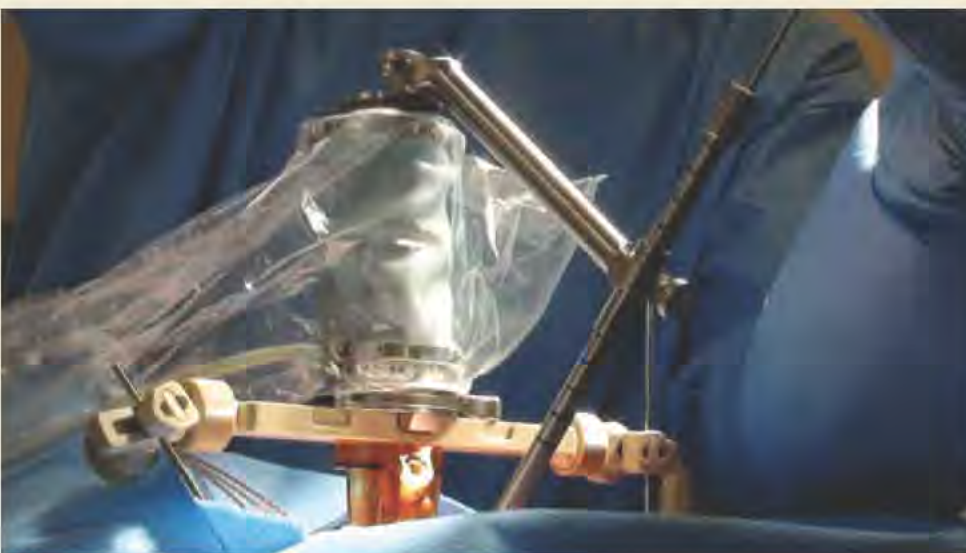


Figure 1: Mazor SpineAssist Robot

workstation sends the robot to the preplanned position. For pedicle screws, the workstation designates one of three robotic arms that are easily secured to the top of the robot and provide the support for the drill guides, which are used to access the pedicle at the exact location and with the precise trajectory planned. Although no further fluoroscopy is required, an image in the lateral plane may be taken to confirm that the drill guide is in line with the pedicle to be accessed. Once the pedicle is drilled, a K-wire is placed through the drill guide, down the pedicle and into the vertebral body. Once the K-wire is in place, the pedicle is tapped and the screw placed using standard minimally invasive techniques. This process is quick and typically takes only a few minutes per screw.

Whether there is sufficient benefit to using robotic and CAS techniques to place pedicle screws in lieu of open anatomical landmarks is controversial. Studies to examine the rate of misplaced pedicle screws suggest the rate can be as high as 4.2% in degenerative spinal diseases and 25% in patients with scoliosis.² A recent multicenter retrospective study examining the accuracy of 3271 pedicle screws placed with the SpineAssist demonstrated that 98% of the screws placed were acceptable. No permanent neurological deficits were noted in any of the 635 cases evaluated, of which half were performed percutaneously.³

The Mazor SpineAssist robot is a well-designed, easy to use, accurate positioning device for placing spinal implants in minimally invasive and some open procedures, especially in cases of deformity or small pedicles. In addition to the increased safety of physically placing pedicle screws, there is a significant reduction in the amount of X-ray radiation to patients and staff. Furthermore, with the increased ability to pre-



Figure 2: Planning session for T1 to T8 Pedicle Screws with small pedicles.

cisely match a preplanned trajectory, screw diameter can be more accurately matched to the width of the pedicle, thereby increasing the pull-out strength of the screw.² The end result is to make spine surgery safer for patients, reduce the chance of revisions and complications and improve outcomes. ❏

References:

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