EDITORIAL

Benefits of robotic spine surgery: the future is bright

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ROBOTIC spine surgery has had rapidly increasing adoption over the past decade. Initially cleared by the US Food and Drug Administration in 2004, SpineAssist (Mazor Robotics Ltd.) differed from the pre-existing da Vinci surgical system (Intuitive Corp.), which was used by other specialties that employed a “master-slave” control. The approved spinal robotic system had a shared control system and was technically a “cobot,” which is a computer-controlled robotic device designed to assist a person. While substantial innovation and development has occurred over the ensuing years, these computer-assisted surgical systems still primarily aid in preoperative planning, surgical navigation, and placement of spinal instrumentation by the surgeon.

The spinal robotic system approval was based on image-guided navigation systems as the predicate device. Computer-assisted navigation aids the surgeon in more accurate placement of standard spinal instrumentation. In its current iteration, spinal robot-assisted navigation systems are not very different, primarily aiding placement of pedicle screws and interbody devices. In the article by Shafi et al.,¹ the authors suggest that robotic navigation (RN) can enable the surgeon to use longer and larger-diameter screws compared with more traditional intraoperative navigation, with no difference in the breach rate.

Shafi et al.¹ present their institutional case series of minimally invasive transforaminal lumbar interbody fusions, comparing the results of the conventional intraoperative navigation cases that were performed using a skin-based navigation tracker (SpineMask, Stryker Corp.) versus those performed using the assistance of an image-guided RN system (ExcelsiusGPS, Globus Medical). The authors indicate that all 222 procedures were done by a single surgeon, and that they shifted all their cases to RN after purchasing the technology in February 2019. Using the Gertzbein-Robbins classification system and having three independent blinded reviewers assess pedicle screw accuracy, a similar accuracy of 88% for both cohorts was

inferred, but with significantly larger and longer screws in the RN cohort.

Numerous prior studies have evaluated pedicle screw accuracy using robotic systems compared with freehand,^{2–5} as well as other navigation systems.^{6–10} Retrospective series have suggested that RN is safe and effective, may have increased accuracy in pedicle screw placement,^{2,11–14} and may decrease radiation exposure and operative time^{15–17} compared with fluoroscopy and other navigation systems. The study by Shafi et al.¹ purports that RN allows for fixation with larger and longer pedicle screws, thus achieving greater biomechanical stability without increasing the risk of pedicle fracture, misplacement, or iatrogenic injury of neurovascular structures.

Questions and limitations are naturally raised from the article.¹ Since this was a single-surgeon experience, and all robotic cases were performed after 2019 when the system was purchased, there may be inherent biases in surgeon technique and strategies. The difference in diameter between RN and intraoperative navigation was 7.25 mm versus 6.72 mm, and the difference in length was 48.4 mm versus 45.6 mm. While statistically different, are these differences clinically relevant? Do the statistically significant differences in the directionality of the breaches matter? Do the higher rates of endplate and facet joint violations in the RN cohort matter? And finally, the authors’ conclusion that RN allows for placement of larger and longer screws compared with intraoperative navigation may not be generalizable to all RN platforms and all intraoperative navigation systems by all users. Is it possible that the senior author in this series happened to be more comfortable selecting larger screws when using the robotic platform? Is it possible that the workflow of a skin-based navigation tracker, calibrated pointer, and taps or screwdrivers that may or may not be tracked in real time are as equally effective as intraoperative navigation systems that track all instruments in real time?

Robotic systems are currently unable to decompress,

decorticate, or contour/place rods. But the article by Shafi et al.,¹ as well as the other articles in this issue, suggests that the advantages of the spinal RN system may extend beyond pedicle screw placement. It is possible that robotics enables larger and longer screw placement; perhaps RN can allow the surgeon to be more efficient and decrease radiation exposure to the surgeon. The results reported by Shafi et al. have limitations but certainly add to the body of literature on this topic. Still, we need to remember the adages “never bet against innovation” and “never bet against technology.” It is likely that, in the next decade, we will find expanding uses for spinal robotics, including safer and more thorough decompression, navigated and automated osteotomies for deformity, and potentially even incorporation of artificial intelligence components facilitating smarter operations. The future is bright.

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Disclosures

Dr. Theodore is the inventor of the ExcelsiusGPS robot manufactured by Globus Medical. He is entitled to royalty payments and is also a paid consultant to Globus Medical. He is also a consultant for Misonix, receives royalties from DePuy Synthes, is a patent holder with Globus Medical and DePuy Synthes, and has direct stock ownership in Globus Medical.

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