INTRODUCTION

Robotics in neurosurgery

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THE past 2 decades have seen the rapid development and commercialization of numerous robotic systems in surgery. In terms of growth and adoption, the laparoscopic/thoracoscopic platforms such as the da Vinci Surgical System have experienced the greatest increases, and in 2015 over 700,000 surgical procedures were performed using this system. Growth in this area continues, and it has been projected that use of the robot for procedures such as a minimally invasive colectomy will increase over the next 10 years by 38%.³ Numerous other competitive platforms are also being developed due to this early success. This includes joint ventures such a recent collaboration between Google/Alphabet and Johnson & Johnson that plan to leverage machine learning and perhaps iterate on the “slave” role of robots. Interestingly, to date neurosurgery has not seen as broad an adoption of robotic techniques.

However, the field of neurological surgery is well suited for the incorporation of robotic assistance.² Traditionally, several aspects of our subspecialty lend themselves to the need and implementation of robotics, including the following: 1) the rich history of neurosurgical innovation in stereotaxy and navigated localization; 2) the tight anatomical confines that are armored by and oriented very specifically to bony structures; 3) the microsurgical nature of our procedures; 4) the highly technical nature of the field; 5) the growth and need for growth in minimally invasive neurosurgery; and 6) a culture that adopts and embraces new technology with optimism.

Indeed, the development of the CyberKnife by John Adler, a neurosurgeon at Stanford University, represented perhaps the first true modern application of robotic surgery.¹ The CyberKnife was the first platform that allowed for the entire procedure to be executed without direct surgeon-patient contact and with full control from a remote location. As such, it represented the actualization of robotic neurosurgery.

Thus, perhaps the reason why robotic neurosurgery has been slow to develop has not been for lack of creativity, vision, desire, or capitalization but, rather, because of the

inherent complexity of most neurosurgical operations. The many and varied steps involved in localization, access, and surgical execution would require distinct “robotic competencies.” As such, most of the contributions to this issue of *Neurosurgical Focus* would more accurately be described as “Cobot surgeries,” where the robot assists with a distinct but critical and sometimes difficult task of the operation. This could be the step of anatomical localization, stabilization of the surgeon’s hand during prolonged microsurgical work, or targeting of a pedicle screw. In the future it may be necessary for not just one but several robots to assist in completing a routine neurosurgical procedure such as a craniotomy for tumor resection or a lumbar spinal fusion.

As such, the subspecialty of neurological surgery is likely to overcome many major milestones in robotic technology in the coming years. Our history has already been intricately intertwined with the predecessors to today’s nascent robotic platforms. This will make our future, much like our past, one that is rich with scientific and technological advancements.

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References

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Disclosures

Dr. Wang is a consultant for DePuy Spine, Aesculap Spine, K2M, and Joimax. He reports being a patent holder in DePuy Spine and owning stock in ISD.