Introduction: the rise of the robots in spinal surgery

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In his 1920 science fiction play *R.U.R.*, Czech writer Karel Capek introduced the word “robot” to the English language. The play tells the story of a factory that produces *roboti*, which are living creatures that resemble humans and have the capacity for individual thought. While at first the *roboti* seem content to work for their human masters, they later rebel, ultimately leading to the extinction of the human race.¹ This play and similar depictions of robots in literature and film are probably responsible for the slightly negative reputation of robots in general. Only recently has this perception changed, thanks to the advent of robots that can vacuum our houses and perform other mundane chores.

Raymond Goertz, while working for the US Atomic Energy Commission, is credited with the development of the first robotic arm in 1951.² It was designed to handle hazardous radioactive material. Unimation Inc. developed the first industrial robot in 1961; that robot handled molten die-castings and removed the human element from these labor-intensive, often dangerous tasks. With the development of the Programmable Universal Manipulation Arm (PUMA) in 1978, the robot was sophisticated enough to be introduced to medicine. The first working definition of the word “robot” was published, fittingly, by the Robotics Institute of America in 1980: “. . . a reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks.”⁶ In 1988, the six-degrees-of-freedom flexible arm PUMA 560 was used to guide a needle under CT guidance into the brain.⁴

With the introduction of robotic arms came the ability to use them as surgical assistants. In 1998, Okada et al. described a voice-controlled robot used to hold a thoracoscope.⁵ This type of robot was also used in thoracoscopic spinal surgery. The military, having a vested interest in telepresence surgery, helped fund the development of the da Vinci Surgical System that was approved for use by the FDA in 2000 and designed to facilitate complex, minimally invasive intracavitary surgeries.⁷

In 2004, the FDA cleared the first commercially available positioning device for the placement of spinal instrumentation. At present, several systems are commercially available that utilize robotics for spinal operations. In a recent review, Joseph et al. evaluated the current landscape regarding safety, accuracy, and radiation exposure with the use of these technologies. These authors concluded that “. . . the placement of pedicle screws with robotics appears to be safe, and accuracy appears to be superior to freehand placement, although the data are not conclusive.”³ There seems to be a significant level of interest in this technology; however, only time will tell if it will become commonplace in our field.

In this issue of *Neurosurgical Focus*, we visually explore the expanding role of robotics and image guidance in spinal surgery. New robots used for the first time and existing robots used for novel applications graphically demonstrate how our field is evolving. The days of fearing robots are behind us as members of our specialty begin to embrace the concept of automation. Thankfully, unlike Capek’s rogue *roboti*, surgical robots rising up against us and causing world destruction is unlikely!

KEYWORDS robots; spinal surgery; video

DISCLOSURES The Excelsius GPS robot was co-invented by Dr. Theodore and is manufactured by Globus Medical. Dr. Theodore is entitled to royalty payments on sales of the robot, is a paid consultant to Globus Medical, and owns stock in Globus Medical.

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