Endovascular Robotic Catheters: An Emerging Transformative Technology in the Interventional Radiology Suite

■ Sandeep Rao, MD, MBA

ABSTRACT: **Robotic usage in endovascular procedures is currently in its infancy, but the technology has the potential to introduce significant changes to the interventional radiology operating environment. Remotely controlled robotic systems enable operators to manipulate catheters and perform a range of procedures, while stationed a safe distance from the radiation field. The purpose of this article is to describe the Magellan Robotic System, its current uses, and its potential role in the interventional radiology suite. (J Radiol Nurs 2016;35:211-217.)**

KEYWORDS: **Robotics; Interventional radiology; Radiation.**

BACKGROUND

The usage of robots in medicine is predicated on providing physicians with a remote system allowing increased control, precision, dexterity, and range of motion.

The roots of endovascular robotic usage are derived from the initial seeds of robotics in surgery. In 2011, surgical robotic systems were used to perform over 125,000 hysterectomies and 100,000 prostatectomies worldwide (Paul, McCulloch, & Sedrakyan, 2013). Endovascular robotic catheters were developed by Hansen Medical, founded in 2002 by Frederic Moll, who had also cofounded Intuitive Surgical, manufacturer of the da Vinci Surgical System. The da Vinci Surgical System is comprised of a console and computer, which allows a surgeon to control a bedside surgical cart consisting of robotic arms to perform a procedure remotely.

Similarly, the Sensei X and Artisan robotic systems (Hansen Medical, Mountain View, CA) were developed for remote catheter control in electrophysiology procedures in the cardiovascular system. The Magellan Robotic System (Hansen Medical) is the second generation of the initial concept of robotically steerable catheter systems but designed for use in peripheral blood vessels. The Magellan system is the only CE (Conformité Européene)-marked and Food and Drug Administration–approved robotically steerable endovascular catheter system for use in the peripheral vasculature available on the market today.

Traditional manual methods of vessel catheterization are based on a series of interactions between a wire and the adjacent vessel wall, in which a catheter and wire are pushed through the vasculature. In contrast, the concept of robotic catheterization is built on the potential ability to drive a wire and catheter directly into the vessel of interest.

Manual usage of traditional catheters is limited by the preshaped curves inherent in the design of each catheter, thereby limiting control of the catheter tip.

Sandeep Rao, MD, MBA, Hospitals of Providence, El Paso, TX.

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Corresponding author: Sandeep Rao, Hospitals of Providence, 1625 Medical Center Drive, El Paso, TX 79901. E-mail: srao7@yahoo.com

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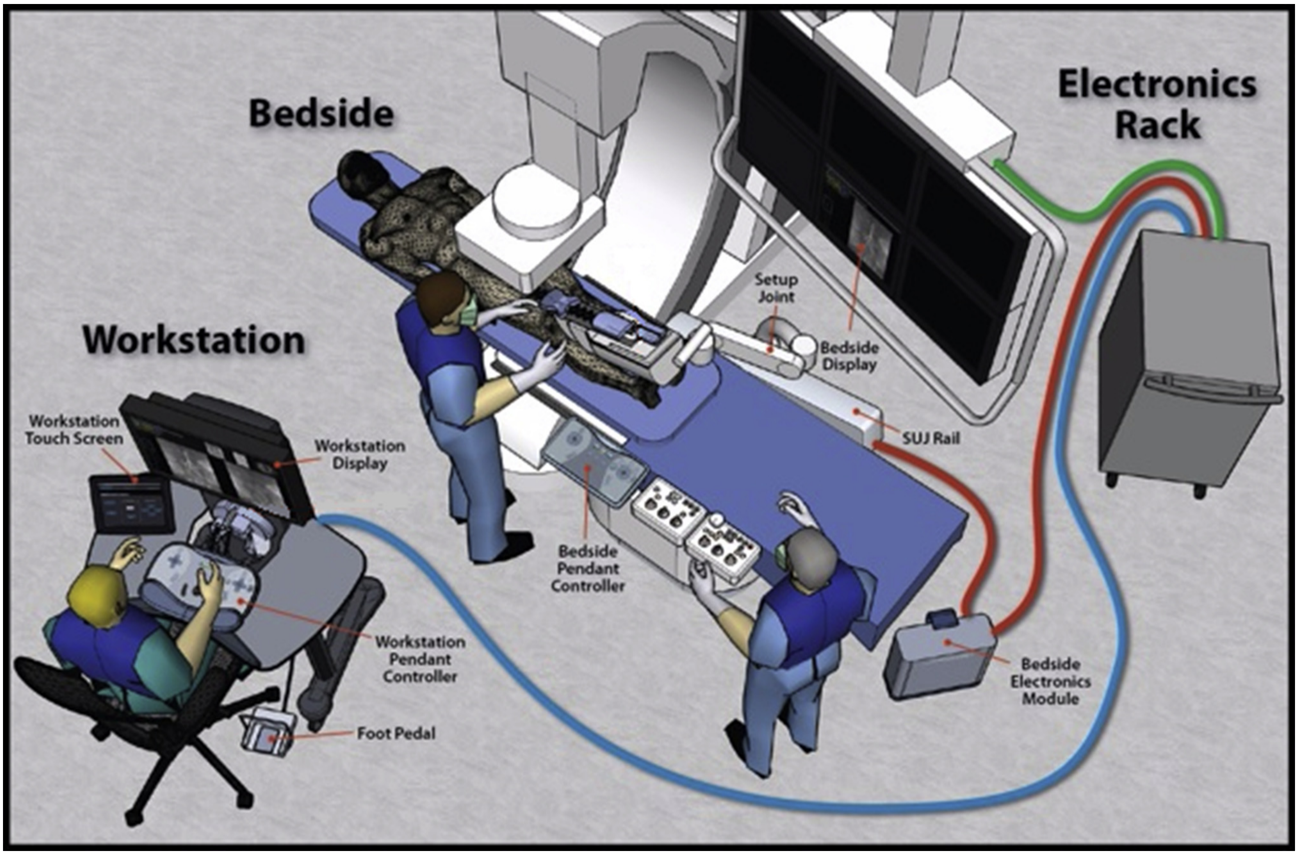

Figure 1. Magellan Medical Vascular Catheter Control System (VCCS). Source: www.hansenmedical.com.

In contrast, robotic catheter technology provides 360° control of the catheter tip, facilitating selection of the lesion or vessel ostium.

Magellan Robotic System

The Magellan Medical Vascular Catheter Control System (VCCS) allows the physician to remotely control a catheter under live fluoroscopic imaging (Figure 1). The physician sits at a workstation console outside the fluoroscopic field. At the workstation of the VCCS, the physician watches the live fluoroscopy on the workstation screen and enters commands for Magellan Catheter or guidewire motion by engaging momentary buttons and switches. The physician commands are processed into commands, checked by safety watchdog software, and sent to the patient bed where motors articulate Magellan catheter pull wires and insert or retract the Magellan catheter and guidewire. The Magellan catheter and guidewire move immediately, but slowly, in response to the physician's commands, only while the console buttons are held.

The Magellan VCCS consists of three basic elements (Figure 2): a remote workstation (Figure 2A) where the physician sits and interfaces with the robot, an electromechanical robotic catheter manipulator (Figure 2B), and a selection of custom steerable catheters (Figure 2C). The robotic system also includes an input device for the operator to enter commands, a computer for processing and transferring the commands into independent Magellan catheter, and guidewire motions.

All Magellan catheters provide control at the catheter tip and the ability to deflect the tip in all configurations independent of the path of the catheter. FDA-approved catheters currently available have the following specifications include catheters with outer diameter of 10 Fr, 9 Fr, and 6 Fr.

CASE REPORTS

A 53-year-old female with 3.6-cm hepatocellular carcinoma in the right lobe of the liver underwent robotic-guided transarterial chemoembolization (TACE). Three months prior, she had previously undergone TACE via traditional manual approach. Both procedures were performed with nurse-administered conscious sedation with fentanyl and midazolam.

Robotically guided subselective catheterization of a right hepatic arterial branch feeding the tumor was successful using 6-Fr Magellan robotic catheter for