Investigating Robotic Neurointerventions with an Eye Toward Remote Stroke Treatment

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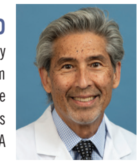

The timeliness of treatment plays such a large role in determining outcomes for stroke patients that travel time to an adequately equipped and staffed medical center can become highly problematic, particularly outside of urban centers. Remotely controlled robotic interventions could help reduce the heavy toll exacted each year by delayed stroke treatment, but there is much work to be done in laying the groundwork for this technological solution.

Left: Sterile Corpath GRX patient-side robotic system during setup. **Right:** Lead-shielded remote Corpath GRX control station during cerebral angiography procedure.

Robotic control for neurointerventional procedures can offer advantages over manual control even when there is no need for the procedure to be performed remotely. When operating the controls of a robot, the neurointerventionalist can work from a safe location, away from possible radiation exposure and freed from the need to wear lead protection. Robotic control may even prove to have value for interventional radiologists who are learning procedures that are new to them by providing an enhanced margin of safety in how they manipulate their tools and devices. Researchers are also looking into ways to add a layer of artificial intelligence to help operators navigate complex three-dimensional anatomy and to further enhance the safety and efficiency of using a robot for these procedures.

"The robot may have benefits because of greater fine control over the movement of the devices. Using joystick controls and having geared mechanisms, you can do various incremental movements potentially more accurately than with manual control," says Gary Duckwiler, MD, professor of radiology and neurosurgery, and chief and fellowship director of the Division of Interventional Neuroradiology. "But the huge potential for this is in determining if we can do remote work with the robot."

The robot that is currently available and FDA approved for neurointerventional procedures is being used for diagnostic cerebral angiography and carotid stenting, which can be done utilizing a single catheter. "Driving one catheter up requires a certain number of gears and channels; driving two catheters up requires additional gears and channels," explains Dr. Duckwiler. "Ultimately, to do a full stroke case will require multiple channels, and that capability is not currently available, though it is under development."

UCLA currently has the single-catheter robot installed in its clinical angiography suite and has begun using it in patient care. A second, dual-catheter robot will soon be installed in UCLA's

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research facility. While this device is not yet FDA approved, it is being used by centers in Canada and France to treat brain aneurysms and will be an important part of investigations being carried out at UCLA to pave the way for robots to be used in remote neurointerventional procedures.

Working with other sites in the UC system — UC San Francisco also has a robot in its clinical practice — Dr. Duckwiler and other UCLA neurointerventionalists are delineating the workflow, processes and requirements to enable remote work. “We’re working with our fellow institutions on range-finding for the things that are going to be necessary to do remote procedures,” says Dr. Duckwiler. “Things like: do I wear a headset; how many cameras do I need in the room to see the patient, the groin and the associated staff; how do I control the angio suite and X-ray in that room; how many channels of communication do I need when I operate; what is the time lag; what speed do I need from my internet connection to drive different parts of the procedure. Before we actually put a catheter in a remote patient, all that infrastructure is critical.”

Following this work on the necessary external conditions for remote work, Dr. Duckwiler and his UCLA colleagues will begin pre-clinical work within the institution using the robots in the clinical angiography suite and the research facility. They will then expand their work to include pre-clinical remote work with other institutions. “That will form the baseline for requirements moving forward — hopefully in two years or so — to doing remote diagnostic studies using the current, FDA-approved robots in the clinical setting,” explains Dr. Duckwiler. “I will have an expert physician at UCSF at the bedside ready to take over at any time, but I would do the angiogram on the UCSF patient from Los Angeles. They would reverse the process and perform a diagnostic angiography procedure on a UCLA patient.” Meanwhile, the more advanced, dual-catheter robot being installed at UCLA’s research facility will be used for pre-clinical investigation of aneurysm interventions, beginning with local robotic control and advancing to remote pre-clinical work.

Another focus of the pre-clinical investigations will be evaluating the group of devices supported by the robot and how that group may need to be expanded to meet the requirements of performing more advanced procedures. “The current generation of robot doesn’t allow for the full range of wires and catheters we would use under manual conditions,” Dr. Duckwiler points out. “If we’re going to be doing more advanced interventions — aneurysms, stroke, embolizations — we need to understand the full range of devices we would need and how the robot would need to be able to incorporate those devices.”

For Dr. Duckwiler, the ultimate goal is to bring critical procedures that re-establish blood flow to stroke victims who don’t have ready access to expert treatment. Many areas, even moderate population centers, aren’t able to support the teams of experts necessary to offer round-the-clock access to stroke interventions. “There are large swaths of the country and large swaths of the world that don’t have that,” says Dr. Duckwiler. “Our motivation is to be able to bring these life-saving treatments to these individuals who would not otherwise have access to timely care.” R

Catheter manipulation using a push-pull and rotation joystick control soley based on the visual information.