Canadian teams are innovators in development of surgical robots

Experts are devising specialized solutions for cancer patients, small children, and others.

BY SHELDON GORDON

The frontier of surgical robotics is a busy one in Canada, as several medical research centres are adapting the U.S.-made da Vinci robotic system or building their own surgical robots in collaboration with private sector partners. The goal is to help surgeons perform minimally invasive procedures with greater accuracy and speed.

The Centre for Surgical Invention and Innovation (CSII) in Hamilton has incubated a surgical robot to do image-guided, minimally invasive breast surgery. The Centre, which is located at McMaster University and St. Joseph's Healthcare, has been working on the Image Guided Automated Robot (IGAR) project since 2009, in partnership with MacDonald, Dettwiler and Associates Ltd.

The Centre's researchers have spent close to $10-million on development of the robot, tools and patient support.

"We're developing the use of robots to do very precise interventions, using imaging to provide eyes for the robot in an automated fashion," says Dr. Mehran Anvari, scientific director and CEO of CSII and a leading surgeon specializing in minimally invasive procedures. "Basically, we want to remove the surgeon from performing the task but put them at a higher level of supervising, planning, and controlling the [robot's] movement.

"This allows the robot to perform the specific task with a far greater degree of precision than the surgeon's hands can, using imaging as a means of seeing what it's doing and assuring that it's following the right trajectory and completing the task accurately."

CSII researchers "looked at where in the field of medicine such a system could pay dividends immediately in patient care," says Dr. Anvari. "One of the areas we identified was the treatment of breast lumps and breast cancer."

The robot attaches to a magnetic resonance imaging (MRI) machine. If a lump is discovered in the patient's breast, the physician gives the co-ordinates to IGAR, which performs a precise biopsy to determine if the lump is benign or malignant. At virtually the same time, the robot does an ablation of the lump.

The main advantage, in addition to the system's accuracy, is its ability to scan, biopsy and ablate the lump all in one session instead of patients needing a separate appointment for each step.

Without IGAR, mammography can identify lesions which are very small, says Dr. Anvari, "but still the patient needs to undergo a reasonably large biopsy procedure or sometimes even surgery to rule out the possibility of cancer. That is quite worrisome for the patient, it takes time and it leaves an unwanted scar."

"With ablation, though, we destroy the [lump] and some of the surrounding tissue without causing a scar," he says. "It's significantly less invasive than a lumpectomy would be."

The IGAR robot is to undergo a clinical trial among 120 patients in Quebec, Ontario, and the U.S. First, however, it must complete the regulatory approval phase in both Canada and the U.S.

Dr. Anvari hopes this is only the first of several specialized surgical robots that CSII will develop. He cites back surgery, other forms of cancer surgery and trauma surgery as therapies for which the technology could be adapted. "We are at the early phase of development," he says. "We're still going through the regulatory process. We're not ready to sell the technology. We're nowhere near commercialization."

The Centre for Image-Guided Innovation & Therapeutic Intervention (CIGITI), at Toronto's SickKids Hospital, has been developing the KidsArm, an image-guided robot designed to enable surgeons to safely and efficiently do less invasive surgical procedures on children. One of its goals is to reduce the average time of such surgeries by up to 90 percent.

The project, launched in 2010, has received $12-million in funding from the Canada Foundation for Innovation, the Ontario Research Fund, SickKids Hospital and private sector partners.

KidsArm is part of a larger group of projects that are integrated together and synthesize robotics, simulation and imaging," says Dr. James Drake, chief of neurosurgery at SickKids and the head of CIGITI. "It grew out of the recognition that there's no advanced technology suitable for pediatric patients. It's intended to be more than just a smaller da Vinci robot."

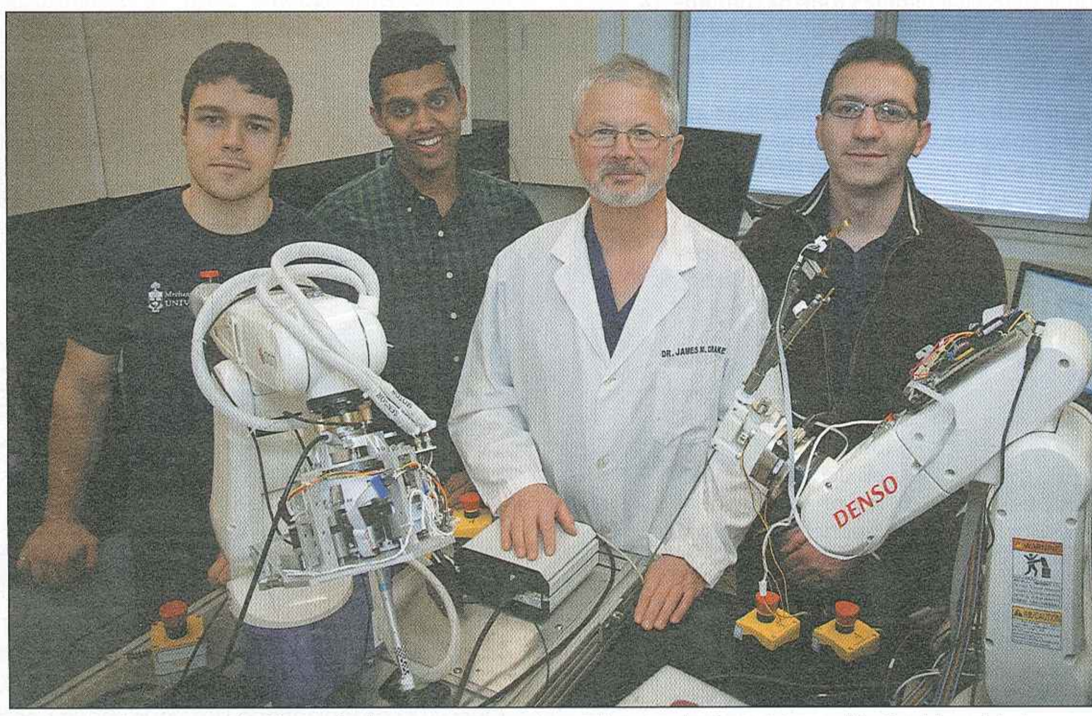

PHOTO: HOSPITAL FOR SICK CHILDREN, TORONTO

Dr. James Drake, centre, with KidsArm development team-members: Robert Brooks, Santosh Iyer, and Dr. Hamidreza Azimian.

The robotic part of the project focuses on new "smart tools" that can be used for laparoscopic surgery on infants. The KidsArm device is a roboticized suture tool which can apply stitches in awkward locations. "It's smart," says Dr. Drake. "It has the ability to take visual images, identify important features in them and then direct the robot to those locations to do the suturing." The device was built in tandem with MacDonald, Dettwiler and Associates Ltd.

"It's been developed to the point where it is able to do the image recognition process," says Dr. Drake. "At the moment, this is for synthetic suture pads and simulated vessels. We're just integrating it with other parts of a surgical system which would include automatic knot-tying and other smart tools which we have developed, such as a special pediatric endoscope."

Not only must the technology be safe, but it must also prove its worth beforehand, says Dr. Drake. "So we have a large simulation platform which has been developed with L3 Communications. They are finalizing a laparoscopic simulator which will be integrated into the KidsArm.

CIGITI has also built physical models of specific pediatric conditions on which the new technology could be used. These include pyeloplasty (where the drainage system off the kidney is blocked), choledochal cyst (where drainage of the bile system is blocked) and tracheo-esophageal fistula (where the esophagus doesn't form properly in a newborn). All of these conditions are difficult to repair laparoscopically.

The KidsArm will not be just one robot for all applications, says Dr. Drake. "We're working on an MRI-compatible robot that will work inside the MRI for biopsies and injections. We're also developing a neurosurgical robot that will help us work in and around the base of the brain."

Dr. Drake expects that clinical trials for the smart tools will start at SickKids within the next 12 to 18 months. "We've embarked on animal testing, and we're now building the tools to Health Canada standards," he says. An initial safety study will comprise a group of 10 patients, with follow-up studies on larger groups to prove clinical efficacy.

CIGITI has filed three patents based on the technology, and is in the process of filing four more. Based on its experience with previous inventions, the Centre is likely to license the KidsArm technology to a medical device company, "but we're available for any kind of corporate model that makes sense," says Dr. Drake.

Researchers at Vancouver General Hospital (VGH) and the University of British Columbia have been conducting experiments with two da Vinci surgical robots for two years. (The hospital has had another da Vinci for clinical use for five years.)

The research robots are located in the Surgical Technology Experimental Laboratory and Advanced Robotics (STELLAR) lab at Vancouver General Hospital and at the Robotics and Control Laboratory (RCL) in Electrical and Computer Engineering at UBC. Teams of surgeons and engineers at both sites are designing, developing, and integrating leading-edge surgical solutions.

The robots were obtained as part of a Canada Foundation for Innovation/BC Knowledge Development fund award coordinated by the Institute for Computing, Information and Cognitive Systems (ICICS) at the University of British Columbia.

"Our focus is on image-guided surgical therapy, meaning we will fuse pre-operative images, including MRI and ultrasound, with the surgical system to allow for a 3D view both inside and outside organs during surgery," says Dr. Chris Nguan, a kidney surgeon at VGH and assistant professor, Dept. of Urologic Sciences, UBC Faculty of Medicine.

The Vancouver-based robotics research program is one of only three centres in the world that have a dedicated research da Vinci robot with both a clinical and technical research partnership with Intuitive Surgical Inc, the robot's maker. The Vancouver researchers are in frequent contact with the Silicon Valley-based technology company, which is looking at ways to commercialize their research.

"Our primary goals in having these research robots here is developing new ways to leverage the robotic platform itself, not necessarily using the robot in a unique or different way," says Dr. Nguan. "The intent is to add new visualization methods, add in almost GPS-like qualities, the whole idea of multi-modal imaging and whether we can co-register this to the robotic operating environment."

Two of the main targets at the moment are prostate cancer and kidney cancer operations. "Some of the things we're developing will help us visualize where the cancer is in the prostate gland and where the critical structures are around the gland, so we can avoid those things while cutting the cancer out," says Dr. Nguan. "This should improve patient outcomes.

"It's the same with the kidney. You visualize where the cancer is in the kidney, even if you can't see it with your eyes," he explains. "We use ultra-sound or an X-ray technology to show it through the robot console while doing the operation." That's unique, says Dr. Nguan, because currently the surgeon operates almost blindly, cutting out the portion of the kidney that they think has the cancer (or the entire prostate) without actually seeing the cancer during the operation.

"Currently, we're conducting clinical trials with that same technology," says Dr. Nguan. "We've been gathering data from it through the use of ultra-sound or X-ray, but not displaying it to the surgeons in real time, because the company needs to see it and help us integrate it."

The integration of imaging into real-time operations isn't new, but Dr. Nguan says that no trials have been run to show that the use of real-time imaging improves clinical outcomes. That's something Dr. Nguan and his team are now doing, partly to prove the worth of the expensive systems to hospital administrators.

Improving patient outcomes with video

CONTINUED FROM PAGE 11

pectation can be met in many ways. For example, a hospital could combine video with technology like digital signage so that patients can speak with a remote operator over video when they approach a directory. This digital concierge could help patients find an office or even let a doctor know if the patient is running late.

Of course, none of these video solutions can be enabled without a robust infrastructure to support the bandwidth, and that's what is putting organizations in a challenging position today. Clinicians already see the value in video solutions and are bringing tools like iPads, which can handle video collaboration, to the workplace with them.

This can put high strains on any facility's network infrastructure, opening it up to potential problems. For healthcare organizations, ensuring the proper network is in place to enable video will be top of mind in the near future, if it isn't already. Video has the potential to drive not only increased efficiency in healthcare, but reduce costs and above all, improve patient outcomes.

Shanti Gidwani is National Senior Director of Healthcare Solutions for Cisco Canada.