Imaging...with heart and innovation

A cutting-edge PET-MRI machine has enabled doctors to find new, less-invasive ways to improve the lives of patients and conduct new research

By **Kira Vermond**

Dr. Maral Ouzounian, opposite, Dr. Patrick Veit-Haibach, left above, and Dr. Michael Domanski are part of the team-based approach at the PMCC that works to maximize innovation using the PET-MRI machine.

ANYONE WHO HAS EVER SLID THROUGH THE TUNNEL OF A MAGNETIC RESONANCE IMAGING (**MRI**) machine likely remembers its raucous whirring and knocking, not to mention the squeeze of a snug 70-centimetre-wide bore.

But for some patients undergoing procedures at the Peter Munk Cardiac Centre (PMCC), the time spent in the life-saving imaging machine will result in something even more – Positron Emission Tomography (PET) images.

Back in April 2016, the centre acquired and installed one of only about 160 PET-MRI combination machines in the world, giving cardiology researchers access to the cutting-edge, hybrid technology. While MR uses strong magnetic fields to generate hyper-detailed images of the body's organs, a PET scan offers information about metabolic changes happening in organs or tissues. The images are generated simultaneously.

It's the best of both worlds, explains Dr. Patrick Veit-Haibach, Clinical Director of the PET-MRI, Joint Department of Medical Imaging (JDMI), and a German radiologist and nuclear medicine physician who came to Canada from Switzerland in April 2017.

"A PET-MRI should give you complementary information about the disease," he says. "At least for certain research questions, it's very important to have real-time simultaneous imaging, so you don't have a delay between one image and another."

Now, the machine is being used to conduct new research, determining everything from how heart and brain health are connected to pinpointing dangerous aortic aneurysms.

HEART AND BRAIN LINK

Take the work being done by Dr. Michael Domanski, Division Head, Cardiology. He's studying the link between aging arteries and neurological disorders such as Alzheimer's, which causes memory loss and cognitive decline.

As people age, their arteries stiffen, which exposes them to increased delivery of energy to the small blood vessels in the brain. "The brain gets more of a pounding," says Dr. Domanski. "So the question is: 'Can we link this pounding to Alzheimer's?'"

Dr. Domanski's team will be using a combination of PET-MRI and hemodynamics – measuring pressure and flow – to examine the effect of arterial stiffness on damage to the brain.

If his team can correlate pressures and flows with changes in the brain, they will have taken a step toward better understanding the link between blood vessel changes and loss of intellectual function.

"That's the grand scheme," he says.

AVOIDING THE WORST

Meanwhile, Dr. Maral Ouzounian, a cardiac surgeon who specializes in aortic disease at the PMCC, has a grand vision of her own. After moving to Toronto from Houston in 2014, she has performed many surgeries on patients with aneurysms or dissections in their aorta.

The aorta is the main artery that carries blood away from the heart to the rest of the body. If an aneurysm forms there – the artery wall weakens, so that it balloons out – it can quickly become a serious, life-threatening medical emergency if the aneurysm tears and bursts.

"If you tear your aorta at home, most of the time you don't even make it to the hospital; it's a fatal event," she cautions.

Most people don't even realize they're living with an aneurysm until it shows up on an unrelated echocardiogram or CT scan. Then the surgeon has a decision to make: operate to remove it or take a wait-and-see approach.

Some aneurysms are stable and are unlikely to rupture. But others are far more dangerous. The problem is, it's not easy to tell one from the other, so physicians depend on their size as a guide. In the part of the aorta that is close to the heart (root or ascending), aneurysms are repaired if they are larger than 5.5 centimetres.

Yet size can be misleading, says Dr. Ouzounian. Some will rupture or dissect when they're smaller, while others remain stable even as they hit the six-centimetre threshold.

But her new research could change when and how surgeons decide to operate. By using the hybrid PET-MRI machine, Dr. Ouzounian is looking at novel ways that imaging can help predict which patients have vulnerable aortas. Not only does it allow her team to examine inflammation of the aortic wall, which can't be completed with a CT scan or an ultrasound, but she can also look at the biomechanical properties of the wall. How stiff or compliant is it? How is the wall handling the pressure?

Once patients have their PET-MRI scan, they're wheeled to surgery, where Dr. Ouzounian removes the aorta and replaces it with graft material. The patient's aortic tissue is then taken to the lab, where it is examined under the microscope and tested for tensile strength. There, she can determine if the aortic wall was, in fact, weak and prone to rupture.

It's early days for Dr. Ouzounian's research, but she hopes the PET-MRI results will give surgeons a new, less-invasive diagnostic tool that will tell them which aortas are vulnerable.

"If we do find parameters that are predictive, we could tailor our therapies more to the specific individual," she says. "The PET-MRI gives us a much more in-depth look at somebody's aorta and allows more personalized decision making."

Considering the risk of death is only less than 1 per cent for elective surgery, it's no wonder Dr. Ouzounian is looking for ways to avoid risky emergency surgeries.

She's pleased she's been able to conduct her potentially life-saving research at the PMCC, where she works daily alongside vascular surgeons, interventional radiologists, cardiology partners and even geneticists.

"I really like the team-based nature of the work at [the] Peter Munk [Cardiac Centre] and the opportunity to do high-end surgery and research," she says. "My goal was to be an academic aortic surgeon – and this is the best place to do it."

WHY USE A PET-MRI?

- It combines the spectacular structural imaging of an MRI with the ability to detect physiological changes in blood flow, viability and function.
- Images are taken simultaneously – quicker than using two separate imaging machines.
- A small amount of ionizing radiation is a real boon, particularly for pediatric patients who must be monitored their entire lives. •