Magnetoelastic sensors

Creating smaller and safer biomedical implants

Two Mayo Clinic studies document a three-fold increase of abdominal aortic aneurysms over the past forty years. An abdominal aneurysm can rupture and cause sudden death. If detected early, however, surgery can take care of the problem about 95 percent of the time. Doctors can fix it with a graft, which reinforces the weakened section of the aorta to prevent rupture of the aneurysm. But what if the graft leaks?

That's a problem that Keat Ghee Ong is addressing. He is devising a wireless sensor, the size of a small paper clip that could be implanted by the graft. "It's a good, easy and inexpensive way to scan the repair to make sure there are no leaks," he says.

Ong collaborates with various medical facilities and formulates his research focus simply by spending a great deal of time talking to physicians and learning their needs and "wish lists."

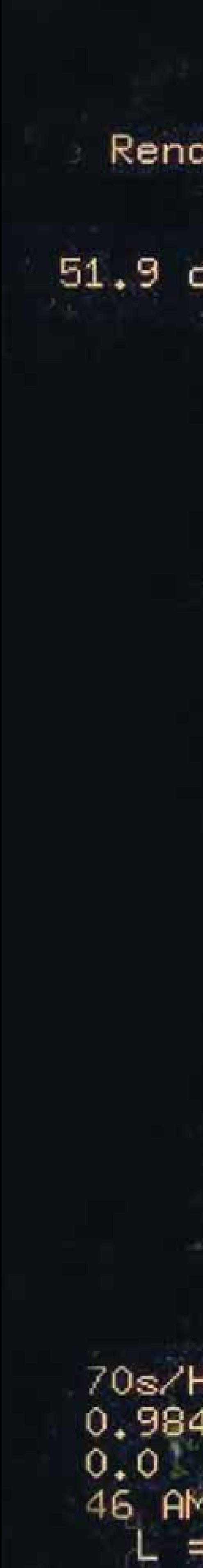
Wireless biosensors can serve as an accurate diagnostic tool for many medical procedures, such as measuring pressure in conduits that carry blood or gastric juices or bile, or recording the compression force on a knee implant. There are three components: a sensor, a signal and a scanner.

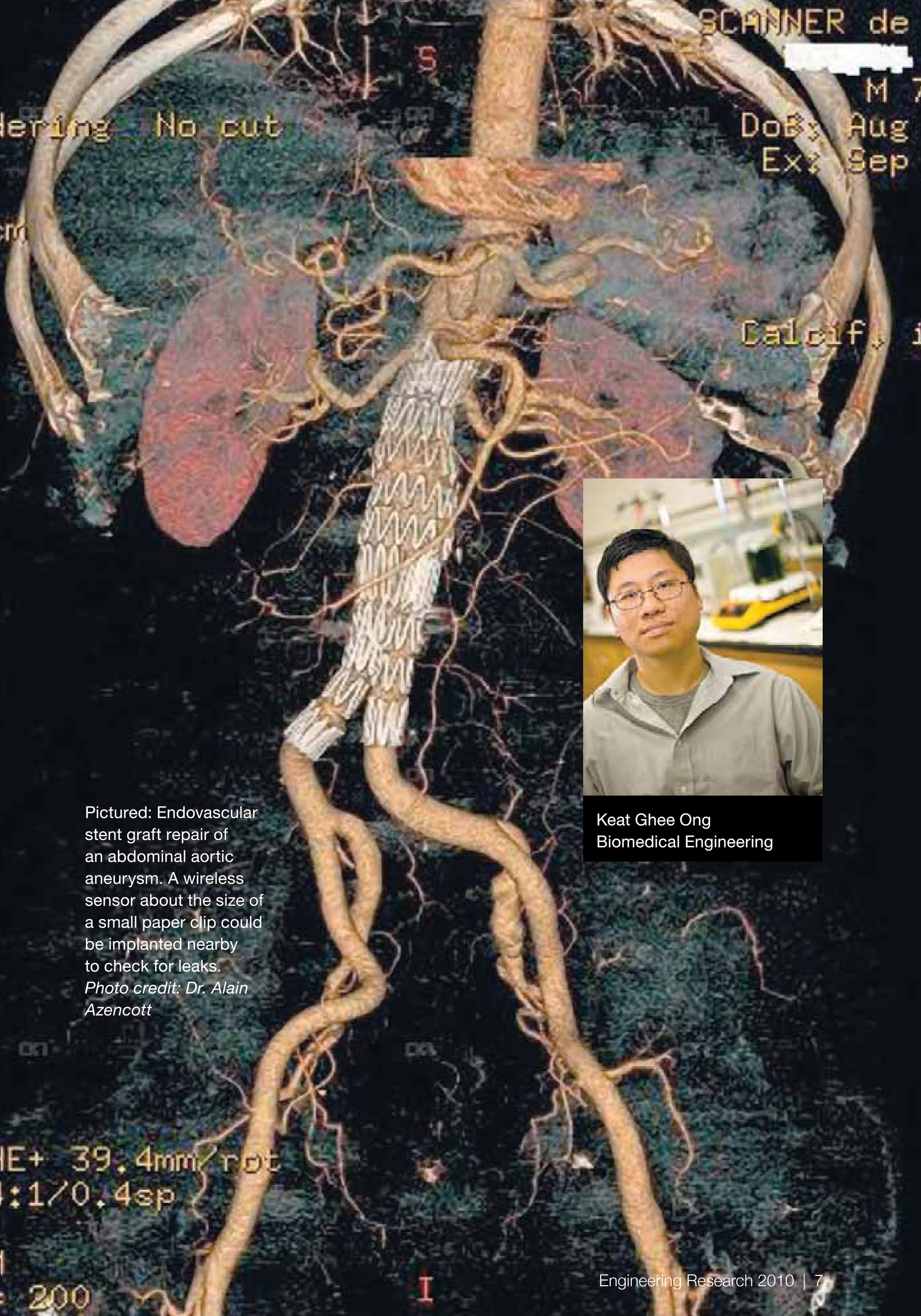
Ong is creating a pressure-sensitive coating material that can be applied to a variety of biomedical implants for real time, wireless measurement of pressure inside the human body. The coating is based on a special magnetoelastic material that generates a secondary magnetic flux when exposed to a low frequency magnetic excitation field. "Due to its unique magnetoelastic property, this secondary magnetic field is also stress dependent," Ong explains. "Once applied to the implant surface, this coating essentially infuses pressure-monitoring ability into an ordinary implantable device."

These magnetoelastic biosensors (some will be mere millimeters in size) will have stress-sensing properties and give off a magnetic signal that the scanner can pick up—similar to the wave and scan function of new credit cards. "There are a lot of wireless passive sensors available already," he adds. "Most have microprocessors and batteries and are too big. The technology is there, but it's not small enough." A self-powered magnetoelastic sensor won't require a space-hogging battery or other energy source.

Ong is exploring other uses, including an artificial knee. He will configure an array of thread-like sensors, in a grid pattern, to measure compression over the entire knee joint—what he calls a "pressure map" of the whole surface. Uneven pressure means uneven grinding, which could cause inflammation and, ultimately, joint failure. "I want to find out the pressure distribution so the surgeon can decide whether the knee implant is successful."

The whole idea of this work, he emphasizes, is to devise a way to record pressures readily in real time. Another goal: measuring pressure when the patient is awake and functioning normally, as opposed to measuring pressure when the patient is sedated or asleep.





Pictured: Endovascular stent graft repair of an abdominal aortic aneurysm. A wireless sensor about the size of a small paper clip could be implanted nearby to check for leaks. *Photo credit: Dr. Alain Azencott*

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