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Sensor-bedazzled balloon catheter speeds up heart surgery

By Janet Fang | Mar 7, 2011 | **0** Comments

A little while ago, cardiologists improved open-heart surgery by using super thin, flexible **balloon catheters** – or tubes inserted into the body to eliminate blockage in blood vessels and to introduce artificial tubes.

But the procedure remained painfully long and required switching between various catheters that do different things. “Those balloon catheters do not have any active surgical power,” says **John Rogers** of the University of Illinois at Urbana-Champaign. “They are just dumb mechanical instruments.”

Now, Rogers and colleagues have created multifunctional balloon catheters with flexible electronic sensors (pictured) that can deliver high-res, real-time information to surgeons, shortening surgery time. And it can also remove the damaged tissue. Diagnostic and treatment capabilities in one!

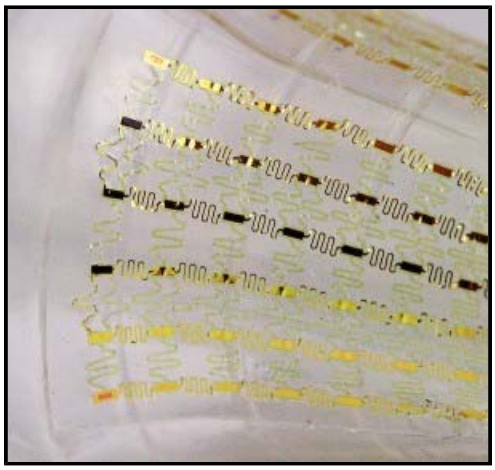
These less invasive cardiac catheters eliminate damaged tissue using heat, temperature and pressure sensors, an LED, and an electrocardiogram (EKG) sensor. They provide info about the depth of lesions, blood flow, electrical activity, and temperature at the exact spot – and deliver cardiac therapy to the patient.

Nature News explains:

> The multifunctional balloon catheter is ideal for quickly diagnosing and treating the cause of irregular heartbeats, says Rogers. Currently, heart surgeons map tissue using pointed catheters with electrodes, which they move around slowly and carefully. When they find the abnormal tissue that can cause irregular

heartbeats, they must insert a separate pointed catheter to remove it. “Most deaths during these procedures arise because of the time this takes,” says Rogers.

It’s difficult to create surgical tools that combine brittle, silicon computer chips and sensors in a material that’s compatible with the soft surfaces of internal organs.



So, for these particular rat heart surgeries, the researchers outfitted balloon catheters with stretchy, connected networks of electrodes and sensors (pictured). The trick was to make the silicon components **a thousand times as thin as usual**. These were connected with serpentine-shaped wires that buckle and change shape as the balloon inflates, rather than fracturing [Nature News].

“You can make an integrated device that can stretch by up to **300%**, from flat to spherical, completely reversibly,” says Rogers. The stretchiness is important because all the necessary medical devices are on a section of the catheter that’s thinner than the rest (since it’s sunken in). There, the sensitive devices are protected during the catheter’s trip through the body to the heart. Once the catheter reaches its destination, the tube is inflated, and the thinner section expands, exposing the electronics to the heart.

“**We put everything on the soft surface of a rubber balloon and blow it up without any of the devices failing**,” Rogers says. After the catheter is in place, the individual devices can perform their specific tasks when needed:

- pressure sensor determines the pressure on the heart
- EKG sensor monitors the heart’s condition
- temperature sensor controls the temp, to not damage good tissue
- LED sheds light for imaging and also provides the energy for ‘**ablation therapy**,’ which eliminates bad tissue by creating lesions in the heart, controlling problems like arrhythmia.

This catheter could also be used in the bladder to monitor stretch and flow or in the lungs to monitor the risk of an asthma attack, according to study coauthor Brian Litt of the University of Pennsylvania. The researchers have started to create real-time maps of electrical activity in the brain during epileptic seizures.

So far, it’s only been used in anesthetized animals, but human trials with a simplified version could begin as early as this year.

The study was published in *Nature Materials* on Sunday.

Top image by Kevin Dowling, bottom image by Dae-Hyeong Kim

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