Georgia Tech Research: Good for the Heart

Georgia Institute of Technology

Valentines Day evokes images of a stylized heart shape, but for a group of Georgia Institute of Technology researchers, the heart is a complex organ that interests them throughout the year.

Georgia Tech researchers are developing new ways to diagnose and treat heart problems -- from advanced imaging techniques and guidance for drug therapies to sophisticated surgical procedures. Georgia Techs emphasis on translational research accelerates the pace at which new heart-related discoveries are put to use in patient care.

Improving Heart Surgery

To advance the goal of minimally invasive cardiac surgery, researchers have developed a technology that simplifies and standardizes the technique for opening and closing the beating heart during surgery.

Apica Cardiovascular, a Georgia Tech and Emory University medical device startup, licensed the technology from the two institutions. The firm recently received a $5.5 million investment to further develop the system, which will make the transapical access and closure procedure required for delivering therapeutic devices to the heart more routine for cardiac surgeons. The goal is to expand the use of surgery techniques that are less invasive and do not require stopping the heart.

With research and development support from the Coulter Foundation Translational Research Program and the Georgia Research Alliance, the company has already completed a series of pre-clinical studies to test the functionality of the device and its biocompatibility. James Greene currently serves as the CEO of the company, which has offices in Galway, Ireland, and in Atlanta.

For more information on this work, visit http://gtresearchnews.gatech.edu/apica-cardiovascular/ [1].

Diagnosing Heart Disease

Levent Degertekin [2] is designing tiny devices micromachined from silicon that may make diagnosing and treating coronary artery diseases easier.

Degertekin, the George W. Woodruff Chair in Mechanical Systems, and Paul Hasler [3], a professor in the School of Electrical and Computer Engineering [4] at Georgia Tech, micromachined intravascular ultrasound imaging arrays with integrated electronics. Placed on catheters inserted into the body, the devices image the arteries of the heart in three dimensions at high resolution using high-frequency ultrasound waves.

The system boasts a more compact design and three-dimensional imaging capability for guiding cardiologists during interventions, such as those for completely blocked arteries. The technology also offers higher resolution than current intravascular ultrasound systems, which help diagnose vulnerable plaque, a leading cause of heart attacks.

Funding for this research currently is provided by the National Institutes of Health. To commercialize the technology, the researchers have formed a startup company called SIBUS Medical, which is receiving assistance from VentureLab [5], a unit of Georgia Techs Enterprise Innovation Institute [6] that nurtures faculty startup companies.

Detecting and Treating Atherosclerosis

With a five-year $14.6 million contract from the National Institutes of Health (NIH), Georgia Tech and Emory University researchers are developing nanotechnology and biomolecular engineering tools and methodologies for detecting and treating atherosclerosis. The award supports the interdisciplinary Center for Translational Cardiovascular Nanomedicine, which is led by Gang Bao [7], the Robert A. Milton Chair in Biomedical Engineering in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University [8].

Atherosclerosis typically occurs in branched or curved regions of arteries where plaques form because of cholesterol build-up. Inflammation can alter the structure of plaques so they become more likely to rupture, potentially causing a blood vessel blockage and leading to heart attack or stroke.

The researchers are working to accomplish four goals:

- Using nanoparticle probes to image and characterize atherosclerotic plaques
- Diagnosing cardiovascular disease from a blood sample
- Designing new methods for delivering anti-atherosclerosis drugs and genes into the body
- Developing stem cell based therapies to repair damaged heart tissue

Additional researchers from the Coulter Department and from Emory University are also contributing to the project. For more information on this work, visit http://gtresearchnews.gatech.edu/cardiovascular-nanomedicine-center/ [9].

Improving Drug Dosing Following a Heart Attack

A research team led by Georgia Tech mechanical engineering [10] assistant professor Craig Forest [11] is designing a device to quickly and accurately personalize a patients drug dosage to prevent blood clots that can cause heart attacks.

When someone experiencing heart attack symptoms arrives at an emergency room, he or she typically receives a standard dose of aspirin and/or clopidogrel to prevent further blood clotting. But that standard dose may not be the best dose for a given individual.

With Forests device, a small blood sample is sent through a microchip containing a network of microfabricated capillaries that mimic the branching coronary arteries around the human heart. Because the branches contain flow restrictions of different sizes, the failure of blood to flow through the branches with smaller restrictions indicates that a higher drug dose may be required.

Determining the necessary dose of anti-clotting drugs can be difficult. Too much of the drug may cause the patient to experience gastrointestinal bleeding. Too little drug may allow additional clot formation and set the stage for another heart attack. Forests device should help determine the right dosage for each patient.

Emory University Department of Emergency Medicine assistant professor Jeremy Ackerman and Georgia Tech Regents professor of mechanical engineering David Ku [12] are working with Forest on this project, which is supported by the American Heart Association.

Examining Heart Valve Leakage

An estimated 1.6 million Americans suffer moderate to severe leakage through their tricuspid valve, a complex structure that closes off the hearts right ventricle from the right atrium. If left untreated, severe leakage can affect an individuals quality of life and can even lead to death.

Research teams led by Ajit Yoganathan [13], Georgia Tech Regents professor and Wallace H. Coulter Distinguished Faculty Chair in Biomedical Engineering, have discovered causes for the tricuspid valves leakage and ways to predict the severity of leakage in the valve. These study results could lead to improved diagnosis and treatment of the condition.

A study published in the journal *Circulation* [14]found that either dilating the tricuspid valve opening or displacing the papillary muscles that control its operation can cause the valve to leak. A combination of the two actions can increase the severity of the leakage, which is called tricuspid regurgitation.

Standard clinical procedures that detail when and how tricuspid valve repairs should be performed need to be developed and this study suggests several items that should be considered in developing those protocols, according to the researchers.

In another study published in the journal Circulation: Cardiovascular Imaging *[15]*, researchers found that the anatomy of the hearts tricuspid valve can be used to predict the severity of leakage in the valve. Using 3-D echocardiograms from 64 individuals who exhibited assorted grades of tricuspid leakage, the researchers found that pulmonary arterial pressure, the size of the valve opening and papillary muscle position measurements could be used to predict the severity of an individuals tricuspid regurgitation.

The study will change the focus and direction of future surgical therapies for tricuspid regurgitation to make them better and more durable, the researchers said.

Researchers from the Coulter Department, Emory University, Childrens Hospital Boston and Mount Sinai Medical Center contributed to these two studies.

For more information on this work, visit http://gtresearchnews.gatech.edu/tricuspid-valve-leakage/ [16] and http://gtresearchnews.gatech.edu/tricuspid-regurgitation/ [17].

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Links:
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[2] http://www.me.gatech.edu/faculty/degertekin.shtml
[3] http://www.ece.gatech.edu/about/personnel/bio.php?id=45
[4] http://www.ece.gatech.edu/
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