NTU scientists develop handheld, high-resolution medical imaging device

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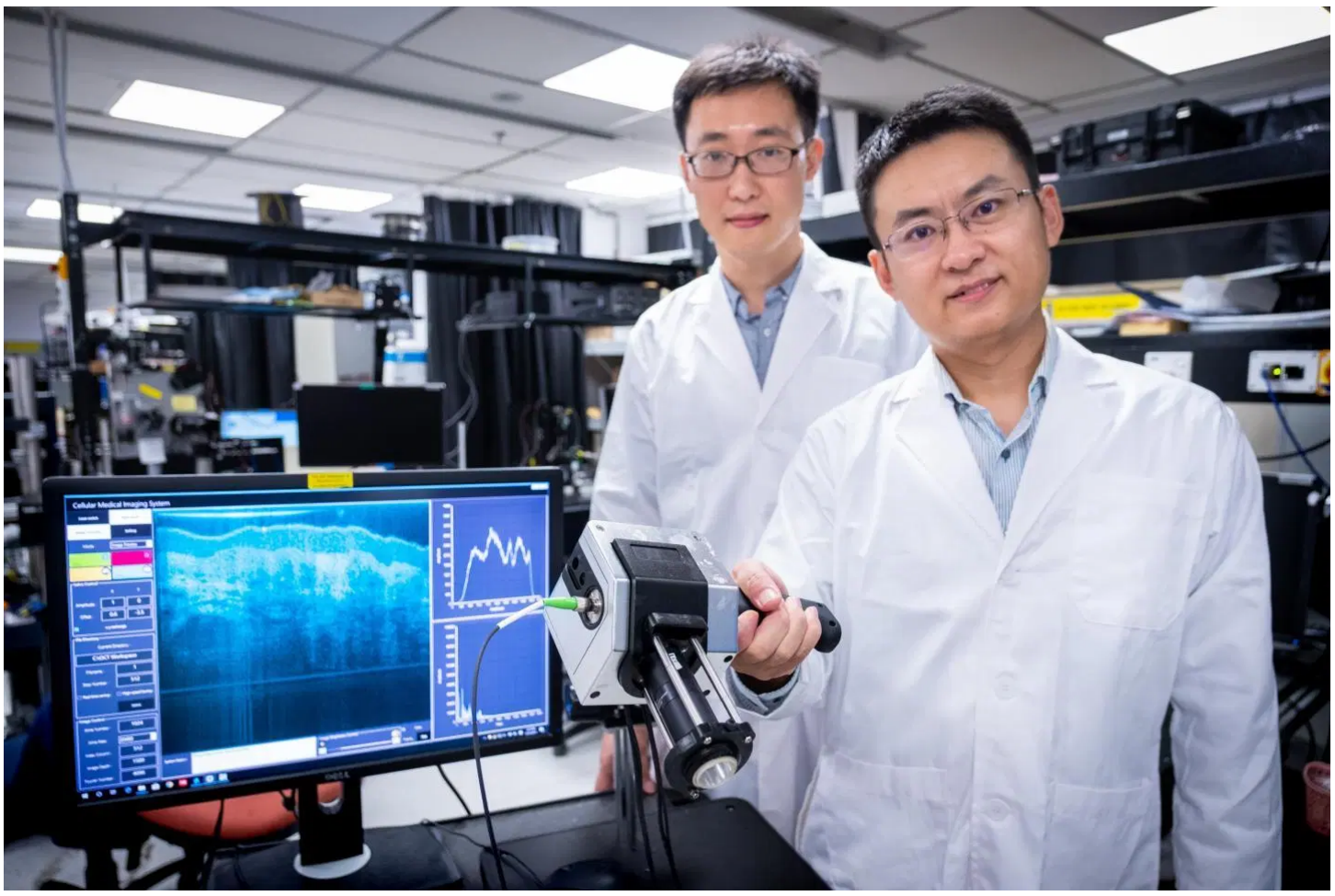

Credit: NTU Singapore

NTU scientists develop handheld, high-resolution medical imaging device with potential for bedside scanning

Scientists at Nanyang Technological University, Singapore (NTU Singapore) have developed the prototype of a handheld medical imaging device that can produce images down to resolutions of 1 to 2 micrometres.

This is detailed enough to spot the first signs of tumours in specific cells and is about 100 times higher resolution than what X-Ray, computed tomography (CT) and Magnetic Resonance Imaging (MRI) machines can provide.

The technology behind the device is a result of six years of optical imaging research and was jointly developed by a team from NTU with researchers at the Harvard Medical School and the University of Alabama, U.S.A.

Relying on a new imaging technology known as micro ‘Optical Coherence Tomography’ (OCT), the device emits a spectrum of light between 700 to 950 nanometres, known as near-infrared light. This harmlessly penetrates human tissue and organs, and the device then measures the delay time of the ‘echo’ from its light waves as they strike different tissue structures. This information will then be used to construct cross-section images of what is being scanned.

The results are sent in real-time to a computer system running software developed at NTU, which assists in diagnosis by assembling the 2-D cross-section images into a three-dimensional picture and rendering different parts in colour.

The NTU researchers say that their prototype was designed to be used by medical professionals who do not specialise in imaging or pathology, allowing them to scan patients using the new device in clinics or at the bedside. Patients would not face the inconvenience of waiting for MRI or CT scanner availability and requiring attendance at a specialised facility.

NTU Associate Professor Liu Linbo, who led the research team, said, “Our device is a fraction of the size of existing machines and produces clear, high-resolution images in real-time. It uses light to harmlessly penetrate the skin, and it does not involve specialised lead-shielded X-ray equipment or MRI scanners. It is small enough to be handheld, so images could be captured by the bedside.”

The prototype device has undergone clinical trials at Wuhan University’s Endoscopic Centre, and has shown promise in detecting abnormal colon polyps to the same level of accuracy as trained pathologists.

During the preliminary trial at the Renmin Hospital of Wuhan University, endoscopists used the device on 58 tissue samples from patients known to have colon polyps – abnormal growths in the colon or rectum. The samples were imaged in real-time by the device, and its assessment of whether they were malignant or benign was found to be 95 per cent accurate after comparison with an evaluation of the same samples, by senior pathologists. These findings were published in

The device is now being commercialised by a Chinese medical technology firm, Suzhou Sai Luo Er Medical Imaging Technology Co. Ltd.

A key promise of the micro-OCT device is its potential ability to spot the first signs of cancers of the colon, stomach and skin, which begin in the nuclei of epithelial cells measuring about 1-2 micrometres. Epithelial cells are part of the barrier between the inside and outside of the body (i.e. lining inside the throat, intestines, blood vessels, and organs) and are almost impossible to image using current machines that cannot penetrate beyond half a millimetre.

“It is our hope that in future, doctors might be able to use a device like ours to precisely identify diseases as they develop at the cellular level, in real-time, and in high resolution,” said Assoc Prof Liu. “Through earlier detection, we believe that patients will receive an earlier diagnosis and if necessary, get treatment faster.”

Not involved in the study, Dr Eng Soo Yap, a Consultant Haematologist at the National University Hospital in Singapore, said, “This is a ground-breaking technology that could have widespread clinical applications. These range from real-time imaging of tissues at a microscopic level to even detecting circulating cancer cells in the blood. All this could lead to early and more accurate detection of cancer. An additional advantage is that being a portable device, it could be used at the bedside, clinics and even in patient’s homes which would extend the accessibility of this technology and cut down on waiting time.”

Prof Liu and his team are conducting more in-depth research into OCT technologies, to further improve the device and extend industry collaboration with other healthcare companies.

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About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, set up jointly with Imperial College London.

NTU is also home to world-class autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Ranked 11th in the world, NTU has been placed the world’s top young university for the past six years. The University’s main campus is frequently listed among the Top 15 most beautiful university campuses in the world and it has 57 Green Mark-certified (equivalent to LEED-certified) building projects, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Novena, Singapore’s healthcare district.

For more information, visit http://www.ntu.edu.sg.

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FDA approves new total wrist replacement device to treat painful arthritis

BY **BIOENGINEER** — March 25, 2020 in **Health**

HSS Innovation Institute and Hand Surgeon play key role in research, design and development

Credit: Hospital for Special Surgery

The US Food and Drug Administration (FDA) has approved a new total wrist replacement device for people seeking relief from painful arthritis. The design is the culmination of three decades of award-winning research by Scott Wolfe, MD, a hand surgeon at Hospital for Special Surgery (HSS), and Joseph J. Crisco, III, PhD, director of the Bioengineering Laboratory at Brown University and Rhode Island Hospital.

The HSS Innovation Institute worked closely with Drs. Wolfe and Crisco to obtain a patent for their research and design ideas. The patent was then licensed to Extremity Medical, LLC, a privately funded medical device company in New Jersey.

“We believe the new wrist replacement, known as the KinematX™ Total Wrist Implant, has advantages over traditional implants,” said Dr. Wolfe, chief emeritus of the Hand and Upper Extremity Service at HSS. “Our extensive research into how the wrist moves helped us design a replacement that more closely matches the anatomy and motion of a normal wrist. This should allow for more natural motion and increased durability compared to currently available implants.”

“In our view, the KinematX™ will be a game changer in the field of wrist replacement surgery,” said Doug Leach, managing director of Biomechanical Innovation at the HSS Innovation Institute. “Current wrist replacement devices are relatively dated. The new implant design leverages the clinical and bioengineering experience of Drs. Wolfe and Crisco, their seminal research, and modern-day engineering and design principals of total joint replacement in general.”

Wrist arthritis is one of the most common and debilitating conditions treated by hand surgeons, affecting about five million people in the United States. A fusion of the wrist bones can alleviate pain, but patients are often limited in performing some activities. Wrist joint replacement surgery was proposed five decades ago as an option to relieve pain and restore function.

“Most people are familiar with total joint replacement in the knee or hip, which is much more common and highly successful,” said Dr. Wolfe. “Total wrist joint replacement has not enjoyed the same degree of success. Historically, some studies demonstrate failure rates of near 50% within 5 to 10 years, mainly due to loosening of implant components.”

Dr. Wolfe and his longtime colleague, Dr. Crisco set out to design a better wrist replacement 30 years ago. The first step was to unravel the complexity of how individual bones move in a normal wrist and in one that has sustained an injury. Their research led to the design and validation of a noninvasive three-dimensional motion analysis system to measure wrist kinematics, which describes the wrist motions necessary for a wide range of activities. Armed with that information, they sat down at Dr. Wolfe’s kitchen table and started sketching out their idea for a novel wrist replacement based on their research.

Over the years, Drs. Wolfe, Crisco and colleagues have received more than $10 million in research grants from the National Institutes of Health to study the wrist. They have published hundreds of papers in peer-reviewed journals.

In 2017, they received the Kappa Delta Award from the American Academy of Orthopaedic Surgeons and the Orthopaedic Research Society, considered one of the highest honors for an orthopedic researcher.

The wrist is highly complex, made up of more than a dozen individual joints formed by eight small bones that collectively make up the wrist. It was previously believed that the wrist moved the hand in two different planes – up and down or side to side. The research by Drs. Wolfe and Crisco demonstrated that during many activities, such as throwing a ball, hammering a nail or pouring a glass of water, the wrist doesn't move in just one of these directions. It accomplishes the action by combining movements in both planes.

"Traditional wrist replacements often constrain the wrist to move in one plane at a time, and this puts stress on surrounding joints," said Dr. Wolfe. "The increased loads on the implant-bone interface often lead to prosthesis loosening and mechanical failure. In addition, traditional implants often make it difficult or impossible to return to some activities, such as tennis or golf."

The KinematX™ is the only wrist replacement that is computer-designed to mimic the kinematics, or motion, of a human wrist – movements that are instrumental in throwing, hammering and other high-performance activities, according to Dr. Wolfe. The unique design should enable the implant to be more durable than traditional wrist replacements.

Surgery with the KinematX™ entails replacing the proximal carpal row bones of the wrist, which are those most severely affected by osteoarthritis. The device utilizes modular components in various sizes to replicate the complex anatomy of the wrist and allow the motion necessary for occupational, recreational and household activities.

The Innovation Institute at HSS played a key role in the development of the new wrist replacement. "Our goal is to work with talented HSS physicians, inventors and entrepreneurs to empower them to develop innovations in musculoskeletal health that could improve or even revolutionize patient care," Mr. Leach said.

Wrist replacement surgery with the KinematX™ will be performed on an outpatient basis. Dr. Wolfe says he already has a waiting list of individuals who are good candidates. A patient registry will be established at HSS and other leading medical centers across the country to track data on outcomes.

Extremity Medical, LLC will be responsible for the manufacture and distribution of the KinematX™ Total Wrist Implant, which is expected to be available before the end of the year.

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About HSS | Hospital for Special Surgery

HSS is the world's leading academic medical center focused on musculoskeletal health. At its core is Hospital for Special Surgery, nationally ranked No. 1 in orthopedics (for the tenth consecutive year), No. 3 in rheumatology by U.S. News & World Report (2019-2020), and named a leader in pediatric orthopedics by U.S. News & World Report "Best Children's Hospitals" list (2019-2020). Founded in 1863, the Hospital has one of the lowest infection rates in the country and was the first in New York State to receive Magnet Recognition for Excellence in Nursing Service from the American Nurses Credentialing Center four consecutive times. The global standard total knee replacement was developed at HSS in 1969. An affiliate of Weill Cornell Medical College, HSS has a main campus in New York City and facilities in New Jersey, Connecticut and in the Long Island and Westchester County regions of New York State. In addition, HSS will be opening a new facility in Florida in early 2020. In 2018, HSS provided care to 139,000 patients and performed more than 32,000 surgical procedures, and people from all 50 U.S. states and 80 countries travelled to receive

treatment by a team of interdisciplinary experts. In addition to patient care, HSS leads the field in research, innovation and education. The HSS Research Institute comprises 20 laboratories and 300 staff members focused on leading the advancement of musculoskeletal health through prevention of degeneration, tissue repair and tissue regeneration. The HSS Global Innovation Institute was formed in 2016 to realize the potential of new drugs, therapeutics and devices. The HSS Education Institute is the world's leading provider of education on musculoskeletal health, with its online learning platform offering more than 600 courses to more than 21,000 medical professional members worldwide. Through HSS Global Ventures, the institution is collaborating with medical centers and other organizations to advance the quality and value of musculoskeletal care and to make world-class HSS care more widely accessible nationally and internationally. http://www.hss.edu.

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