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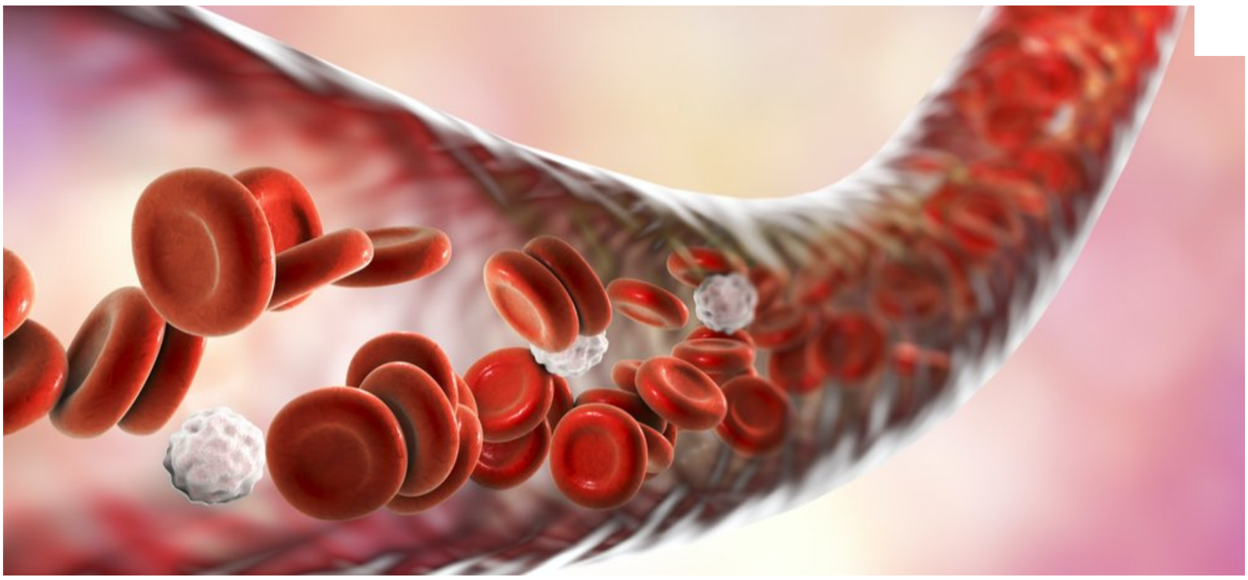
# Researchers develop device for less invasive blood vessel repair procedures



***A team of researchers led by Nanyang Technological University, Singapore (NTU Singapore) has developed a device that offers a quicker and less invasive way to seal tears and holes in blood vessels, using an electrically activated glue patch applied via a minimally invasive balloon catheter.***



This device could eventually replace the need for open or keyhole surgery to patch up or stitch together internal blood vessel defects.

After inserting the catheter into an appropriate blood vessel, the glue patch – nicknamed 'Voltaglue' – can be guided through the body to where the tear is located and then activated using retractable electrodes to glue it shut in a few minutes, all without making a single surgical cut.

Patented by NTU and Massachusetts Institute of Technology (MIT) scientists, Voltaglue is a new type of adhesive that works in wet environments and hardens when a voltage is applied to it.

The catheter device that deploys Voltaglue is jointly developed by Associate Professor Terry Steele from the NTU School of Materials Science and Engineering, former NTU PhD student Dr Manisha Singh, now at MIT, and Associate Professor Ellen Roche from the Department of Mechanical Engineering and Institute for Medical Engineering and Science at MIT, USA.

This catheter device is the first proof-of-concept application of Voltaglue in a medical setting since it was invented by Assoc Prof Steele in 2015.

Their research was published in the peer-reviewed scientific journal Science Advances in April.

Assoc Prof Steele said: “The system that we developed is potentially the answer to the currently unmet medical need for a minimally-invasive technique to repair arteriovenous fistulas (an abnormal connection between an artery and a vein) or vascular leaks, without the need for open surgery. With Voltaglue and the catheter device, we open up the possibility of not having to make surgical incisions to patch something up inside – we can send a catheter-based device through to do the job.”

The catheter system is made up of two components:

- The adhesive patch containing Voltaglue called ePATCH, which is applied to the catheter’s balloon,
- a modified catheter with retractable wires that carry electrical current, named CATRE.

The team showed in lab experiments on a pig’s heart that the Voltaglue patch can be safely and effectively administered in a variety of situations, including withstanding the high pulsatile pressure of blood in arteries like the aorta.

The device was used to close a 3mm defect in an explanted pig aorta connected to a mock heart under continuous flow of blood of 10ml per minute.

The catheter is first inserted and guided through the blood vessel. Once at the site of the break, the balloon is expanded so that the injury is covered by the Voltaglue patch.

A small electrical charge is sent through the two wires to activate the patch. The glue's hardness can be adjusted by changing the amount of voltage applied to it, a process called electrocuring. This allows the patch to adapt to various types of tissue surfaces, from relatively smooth aortic tissue to more irregular, uneven surfaces of synthetic vascular grafts.

The patch starts to set after 20 seconds and fully hardens between three to five minutes. Upon hardening, the patch effectively 'glues' the broken vessel together, thereby sealing the two broken ends shut. The wires, deflated balloon, and catheter are then withdrawn.

In this experiment, the team left the patch on the pig heart for 1,000 physiological stress/strain cycles (heartbeats), which, at 70 beats per minute, was around 15 minutes. When the aorta was examined after the experiment, the patch was found to be still successfully sealing the gap.

The paper's first author Dr Manisha Singh, formerly from NTU School of Materials Science and Engineering, said: "Voltaglue is unlike other adhesives in the market as it is voltage-activated, is stable in wet environments and can stick onto soft tissue, making it suitable and effective for repairing blood vessels. By combining it with existing, commercially available catheters, we have developed a new delivery mechanism that is minimally invasive, yet flexible and adaptable. This system shows promise for a diverse range of medical applications, as the suitability of the patch could be tailored according to the needs of the patient."

The catheter is designed for use in vessels ranging from 7.5 to 30mm in size, making it suitable for sealing defects in organs and vessels such as the aorta, intestine, and oesophagus.

Both Voltaglue and the patch are made with bioresorbable material, which are entirely degradable and dissolve after a few weeks.

These properties make the catheter suitable for potential applications such as vascular grafting, a common surgical procedure to redirect blood flow from one area to another, or to seal off blood flow to tumours, in order to kill them off.

Giving an independent comment on this innovation, Associate Professor Andrew Chin, senior consultant in the Department of Hand and Reconstructive Microsurgery at Singapore General Hospital, said: "The clinical application of this device in delivery of bio-adhesive has tremendous potential not just for vascular anastomoses (vessel connection), but other soft tissue fixation which significantly cuts down on the time taken to complete at this current point in time where suture materials are being used."

Drawing on their findings, the researchers foresee that the catheter device may someday be used to deliver patches to repair birth defects such as holes in the wall of the heart.

The research team has filed a joint patent for this device, shared between MIT and NTUitive, NTU's innovation and enterprise company.

The commercial potential of the catheter system highlights NTU's commitment to innovation in its recently announced 2025 strategic plan, which aims to translate research into products and outcomes that enhance the quality of life.

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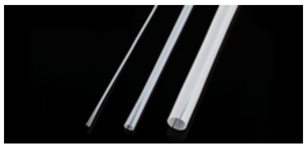

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