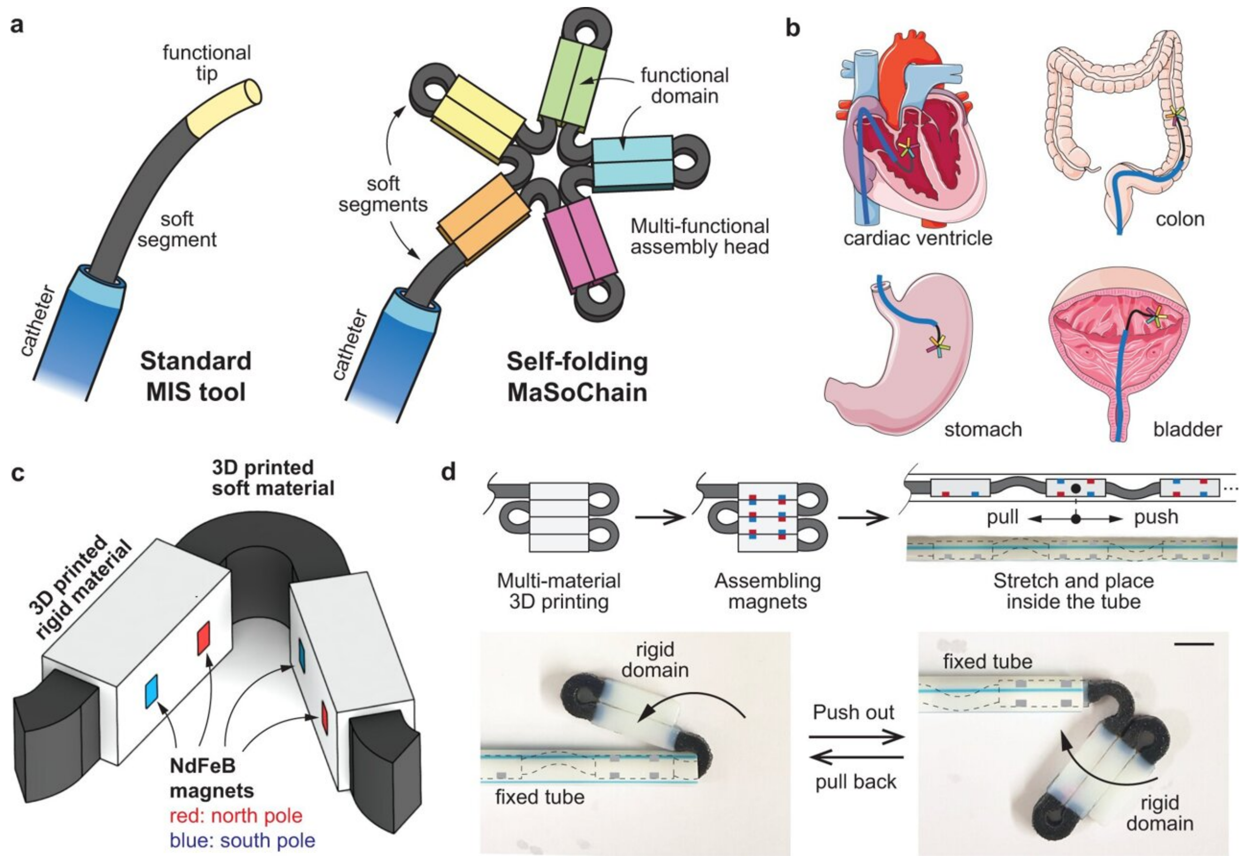
Self-folding surgical tools fit through a catheter for minimally invasive surgical procedures

April 12 2023, by Fabio Bergamin



Concept and structure of magnetic soft-robotic chains (MaSoChains). a A schematic illustration of a standard MIS tool and a self-folding MaSoChain. The MaSoChains can self-fold into large assemblies at the tip of the catheter with multiple functional domains. b Potential application scenarios for MaSoChains. When pushed out of the sheathing catheter (marked in blue), MaSoChain can fold into large functional structures (colored star) in relatively open chambers in the human body (e.g., heart ventricles, colon, stomach, bladder). c The basic self-folding unit of MaSoChains, composed of rigid segments (in white) connected by soft segments (in black). Small NdFeB magnets are embedded at the same height as the surrounding surface. d (upper) A schematic illustration of the preparation of the MaSoChains. After assembling the small magnets, the MaSoChains are stretched and placed inside the sheathing tube, where elastic and magnetic energies are stored. (lower) The folding process of MaSoChain is initiated when a new segment is pushed out of the sheathing tube. The elastic energy (stored in the soft segment) folds the MaSoChain, and magnetic energy secures a stable assembly (marked as the rigid domain). MaSoChain is disassembled by pulling back with guiding of the fixed tube. The scale bar is 5 mm. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-36819-z

A camel cannot go through the eye of a needle. But researchers at ETH Zurich have now achieved something that—figuratively speaking—comes quite close. They have developed a new approach to minimally invasive surgical instruments, allowing large objects to be brought into the body through a narrow catheter. Their demonstration study has been published in the journal *Nature Communications*.

This works as follows: The researchers disassemble such devices into individual parts and then slide them through the catheter in a row, like a string of pearls. At the end of the catheter, the parts assemble themselves into a predefined shape thanks to built-in magnets.

In its research, the team—led by ETH doctoral student Hongri Gu, who is now a postdoc at the University of Konstanz—was primarily concerned with demonstrating the many possibilities of this new approach. In a relatively simple way and using 3D printing, the scientists also constructed an endoscopic grasper. Moreover, they showed that the new approach makes it possible to assemble an endoscope head consisting of three parts.

For their prototypes, the researchers combined soft, elastic segments with rigid segments, into which the tiny magnets are incorporated. This design method also makes it possible for an endoscope head to perform movements with very tight radii and angles that aren't feasible with today's endoscopes. This increased mobility broadens the possibilities when designing devices for minimally invasive surgery on organs such as the intestine or the stomach.

More information: Hongri Gu et al, Self-folding soft-robotic chains with reconfigurable shapes and functionalities, *Nature Communications* (2023). DOI: 10.1038/s41467-023-36819-z

Provided by ETH Zurich