Flexible surgical needle offers enhanced precision

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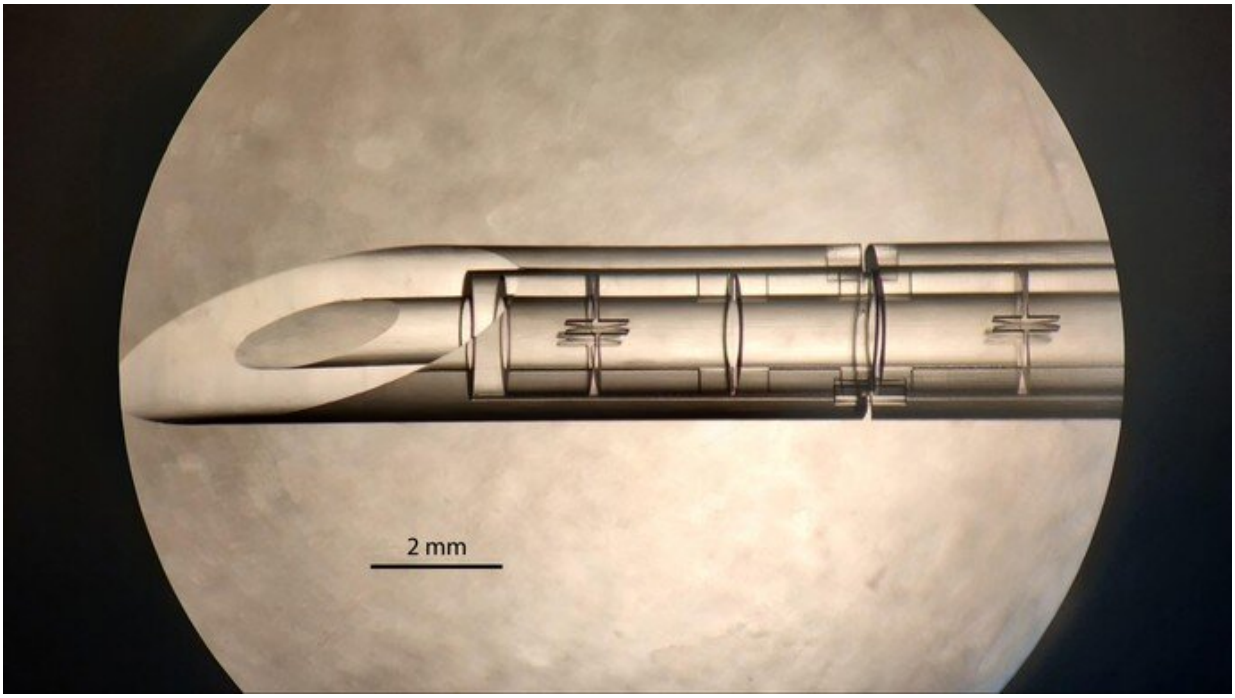

Credit: FEMTOprint

Engineers from EPFL and the University of Strasbourg have developed an innovative surgical needle whose trajectory can be corrected on the fly, thanks to a flexible tip controlled with a simple button. Intended for use in image-guided surgery, the needle offers greater precision in surgeon's movements and reduces the risk for patients.

A growing number of surgical procedures are being performed with minimally invasive techniques. Surgeons make an incision just a few centimeters long and then use long, thin instruments and needles to reach the target tissue, with their movements guided by imaging technology.

However, even the most careful surgeons often have to adjust the needle 's trajectory as they go along, pulling it out and repositioning it. In some cases, the tissue can be extremely hard to reach because it's tucked away behind an organ, for example. Such probing with a stiff needle can make surgeries last longer and increase the risk of trauma or infection.

Charles Baur, an engineer at EPFL's Instant-Lab, working with et Lennart Rubbert, researcher at Strasbourg University, has developed a new kind of flexible needle (ARC) that addresses this problem. A button on the needle's handle allows surgeons to correct the needle's trajectory, enabling them to reach diseased tissue more quickly and, if needed, explore nearby tissue without pulling the needle out.

A fully mechanical system

"Today the perception in hospitals is that the stiffer a needle is, the greater precision it can deliver," says Baur. That's because a stiff needle makes it easier for surgeons to move the instrument exactly as they want. This kind of stiffness can be found in the needle developed by Baur and his French colleague, but coupled with a tip that surgeons can curve as needed. The whole system is mechanical. "Our needle actually has two tubes, one inside the other," says Baur.

When a surgeon slides the button, the inner tube translates and releases one, two or three tiny segments that move in the direction indicated by the bevel of the needle and therefore by the orientation of the surgeon's hand. For now, only the first few centimeters of the tip are flexible, but the system could be modified to extend that.

"We could also make some noncontiguous segments of the tip flexible while keeping the others stiff. That would allow an infinite number of possible trajectories. It is possible to add additional functions to ensure specific surgical procedures such as electrostimulation, administration of medication on demand or biopsies, to name a few."

Credit: Ecole Polytechnique Federale de Lausanne

The benefits of glass

Baur, together with Rubbert, worked with FEMTOprint, a 3D-printing company for glass devices, to fabricate their needle, while Juan Verde, surgeon at the IHU of Strasbourg helped them finalize the design. Thanks to the high-precision process, the engineers were able to make customized needles with diameters of 0.9–4.5 mm so as to cover a wide

range of surgical applications.

The researchers tested two different types of materials: stainless steel and glass. The stainless steel version is the most advanced because "glass technology is emerging and still requires development. Nevertheless needles are intended for soft-tissue surgery, meaning they won't have to withstand shocks," says Baur.

"We performed resistance tests in silicone which showed that the kind of glass we selected offers numerous benefits: it's biocompatible, hard to deform, can be used with MRI machines, and doesn't create reflections that could interfere with images of the area being operated on."

The flexible needles are almost ready for preclinical trials, and the engineers are actively seeking companies to partner with. "It is possible to add additional functions to ensure specific surgical procedures such as electrostimulation, administration of medication on demand or biopsies, to name a few," notes Baur.

The researchers plan to eventually connect high-precision systems to their device in order to give doctors smarter medical equipment.

Provided by Ecole Polytechnique Federale de Lausanne

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