Commentary: Technology to make the invisible “visible”: Novel optical visualization system for off-pump artificial chordae implantation

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We congratulate Dr Machaidze and colleagues¹ on inventing this new guidance system for transapical off-pump artificial chordae implantation. They conducted a nonsurvival experimental study in a swine model by using a novel guidance system that allows optical visualization of the mitral leaflet. The unique point of this system in comparison with a preinvented transapical cardioscope² is a functional capability of instrument via this device, which consists of 2 parts: an optically clear silicone grasping finger with embedded camera and an opposing ring-shaped finger. Once the leaflet is grasped between these 2 parts, the surgeon is able to visualize the leaflet, enabling precise and reproducible chordae implantation. The optical visualization assisted navigation of the instrument to the mitral valve with short delivery time (average 3.22 minutes) even without ultrasound guidance. Furthermore, optical visualization could inform the quality of leaflet and verification of successful chordae implantation, as in open surgery.

Current off-pump interventions for mitral valve disease include transapical or trans-septal transcatheter mitral valve replacement,³ edge-to-edge trans-septal repair,^{4,5} trans-septal annuloplasty,⁶ or transapical artificial chordae implantation.⁷⁻¹⁰ A first-in-man transapical artificial chordae implantation, the Neo Chord Artificial Chordae Delivery System (NeoChord, Inc, St Louis Park, Minn), was reported in 2010.⁷ After that, the Transapical Artificial Chordae Tendinae (TACT) trial, a prospective multicenter study in Europe, was conducted to evaluate the safety of the procedure.⁸ Acute procedural success was observed in 87%, and safety end points, success rate, and 30-day durability improved through the trial. Another multicenter study in Europe retrospectively investigated 1-year outcomes of 213 patients and reported excellent 1-year survival of 98%.⁹ Kiefer and colleagues¹⁰ reported 5-year follow-up results of early TACT trial patients with acceptable long-

term durability. However, there were several conversions to open surgery observed in these studies, mainly due to injury of a fragile leaflet second to fibroelastic deficiency.

Current artificial chordae delivery is guided by transesophageal echocardiography, which does not allow assessment of leaflet quality. In the present article, the authors emphasized that an advantage of their optical visualization guidance system is obtaining a high-resolution direct image independent of the location and orientation of the instrument inside the heart. In contrast, in its current state, transesophageal echocardiography imaging does not allow accurate images for assessment at the instrument-tissue interface. In addition to ultrasound, necessary for assessment of valve function and determination of neochordae length, there is potential for this technology to improve the precision of placement and quality of neochordae in off-pump mitral valve repair. This may ultimately improve the durability of these novel procedures. Although ultrasound guidance is still necessary to perform this type of procedure (eg, length adjustment, valve function, subvalvular apparatus), their novel system could assess the leaflet quality and provide more safe and precise artificial chordae implantation, and prevent the risk of leaflet injury. Another advantage for the surgeon is the ability to manipulate the guidance system by him/herself compared with completely

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Central Message

A novel guidance system enables precise artificial chordae implantation in the transapical approach. The technology is the first step in more precise structural heart interventions.

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relying on the ultrasound guidance performed by another operator or supporting anesthesiologists or cardiologists.

“Visualization” is the key to performing any intervention, and this is the hallmark of surgical expertise in the management of mitral valve disease. The ability to add direct intracardiac vision to existing ultrasound technology in off-pump valve repair may be an advance toward the accuracy and reproducibility of leaflet repair offered by open surgery.² The authors should be congratulated on providing the new modality enabling optical visualization of the object in the blood flow, which was thought to be impossible before. Although this is an experimental study and not yet applied to prolapsed thickened and redundant leaflet, or in humans, we expect that this technology will be applied broadly to other off-pump mitral valve interventions and may prove useful for more complex procedures¹¹ in the near future.

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