Docket #: S20-202

Minimally Invasive Neochord Devices for Mitral Valve Repair

Stanford researchers have developed two novel, minimally invasive neochordal devices for mitral valve repair. The first, described in S19-432, is a high-impact, minimally invasive, percutaneous, transcatheter device that does not require open heart surgery nor cardiopulmonary bypass. It is administered percutaneously, entering the venous system, targeting the mitral valve through the atrial septum. This approach allows for direct positioning of a neochord spanning the mitral leaflet and left ventricular myocardium, a surgery known as posterior ventricular anchoring neochordal (PVAN) repair. This technology is far superior to existing transcatheter edge-to-edge mitral valve repair technologies because it aims at percutaneously implanting a neochord, as opposed to creating a double-orifice valve, as double orifice valves have been shown to increase harmful stenosis and forces on the valvular system. This technique replicates the gold standard, neochordal repair procedure, while edge-to-edge repair recapitulates an outdated technique that leads to worse outcomes. Moreover, the shorter neochord lengths due to the posterior ventricular targeting has been shown to reduce chordal forces on the valve, leading to a potentially more durable repair.

The second device is a neochord anchoring prosthetic for transapical off-pump mitral valve repair. The device is an elastic post inserted into the apex of the heart following neochord leaflet attachment. This device, functioning like an artificial papillary muscle, serves as an anchor for one or more neochordae. The elasticity and shortened neochord lengths mitigate the elevated chordal stresses associated with apical anchoring, aiming to reducing chordal forces and neochord pull out frequency and minimizing blood leakage.

Dr. Joseph Woo, renowned chairman and surgeon of Stanford Cardiothoracic Surgery, invented these devices and the PVAN procedure, which has been shown to provide tremendous repair results and patient outcomes. Moreover, recent studies

have shown that shorter neochord lengths, accomplished with posterior left ventricular targeting and elastic transapical anchors, result in reduced forces on the neochordae and surrounding existing chordal architecture, translating to very low failure rates, reduced fatigue damage, greater repair durability, and outstanding patient outcomes. The inventions directly address some of the largest concerns regarding treatment of one of the most prevalent valvular diseases in the world, enabling a higher quality repair without the trauma of major surgery nor the rare expertise of surgeons from high volume treatment centers and leveraging advanced, minimally invasive technologies of the future.

Stage of Development:
Proof of Concept

Applications

- Percutaneous, transcatheter, neochordal mitral valve repair in a beating heart
- Stand-alone medical device for implanting artificial chordae with any beating heart
- Concomitant implanted medical device for improving transapical neochordal repair biomechanics and outcomes

Advantages

- -High quality repair technique: These devices are associated with a repair and not valve replacement, preserving the native structures and biomechanics as much as possible.
- -Reduced chordal strains: Shorter length neochordae result in reduced strain in the neochord and surrounding chordal architecture, translating to reduce fatigue and increased durability of the repair
- -Low failure rates: Reduced strains directly result in reduced failure and increased durability.
- -PVAN is an entirely percutaneous and minimally invasive: Percutaneous approach facilitates a minimally invasive technique, which improves recovery times and reduces surgical complications.
- -Transcatheter delivery method: the invention leverages futuristic transcatheter approaches, which allows for wide adoption and clear avenues for robotic

integration and manipulation.

Publications

- Imbrie-Moore, Annabel M., Michael J. Paulsen, Akshara D. Thakore, Hanjay Wang, Camille E. Hironaka, Haley J. Lucian, Justin M. Farry et al. "Ex vivo biomechanical study of apical versus papillary neochord anchoring for mitral regurgitation." *The Annals of thoracic surgery* 108, no. 1 (2019): 90-97.
- Imbrie-Moore AM, Zhu Y, Park MH, Paulsen MJ, Wang H, Woo YJ. Artificial papillary muscle device for off-pump transapical mitral valve repair. *J Thorac Cardiovasc Surg.* 2022 Oct;164(4):e133-e141. doi: 10.1016/j.jtcvs.2020.11.105. Epub 2020 Nov 30. PMID: 33451843; PMCID: PMC8300865.
- Woo, YJ and MacArthur, JW. Posterior ventricular anchoring neochordal repair of degenerative mitral regurgitation efficiently remodels and repositions posterior leaflet prolapse. *Eur J Cardiothorac Surg*, 2013. 44(3): 485-489.
- Paulsen MJ, Imbrie-Moore AM, Wang H, Bae JH, Hironaka CE, Farry JM, Lucian HJ, Thakore AD, MacArthur JW, Cutkosky MR, Woo YJ. Mitral chordae tendineae force profile characterization using a posterior ventricular anchoring neochordal repair model for mitral regurgitation in a three-dimensional-printed ex vivo left heart simulator. *Eur J Cardiothorac Surg. /i>2020 Mar 1;57(3):535-544. doi: 10.1093/ejcts/ezz258. PMID: 31638697; PMCID: PMC7954270.*

Innovators

- Yuanjia Zhu
- Michael Paulsen
- Matthew Park
- Joseph Woo
- Annabel Imbrie-Moore

Licensing Contact

Seth Rodgers

Licensing Manager, Life Sciences

Email