Image Guidance for MitraClip Procedures for Tricuspid Valve Regurgitation

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Introduction: Tricuspid valve regurgitation (TR) is characterized by the back flow of blood from right ventricle to the right atrium. Around 80% of the TR cases are functional and due to annulus dilation (diameter > 40mm) and leaflet tethering caused by pressure overload. Previously labelled as *the forgotten valve*, tricuspid valve and its repair surgeries are getting prominent recently. The MitraClip system (Abbot Vascular, USA), mimicking the Alfieri stich, has been used for several years to repair Mitral-valve regurgitation (MR) by clamping opposing leaflets. This approach has also recently been proposed for the repair of the tri-cusped valve. Typically, the procedure uses transesophageal echocardiography (TEE) and intracardiac echocardiography (ICE) to identify the pathological leaflet (target site causing regurgitation), guide the clip to the target site and deploy the MitraClip to clip the leaflets and stop regurgitation. However, the amount of information provided by ultrasound is limited. Imaging view and tools are adjusted repeatedly until the clip reaches the desired leaflet commissure. Localization of target site and placement of the tools make the TR procedure long and complex.

To address the challenge, we propose to localize/identify the regurgitation site by creating a 3D model of the valve using Conavi Foresight ICE system and overlay Doppler to see regurgitation.

Method: The recently introduced Conavi Foresight ICE probe generates a cone-shaped surface image via rotating transducers. With a 360˚ imaging field of view this 2.5D ICE system also acquires both side-looking and forward-looking views. By taking multiple images, Conavi ICE acquire high resolution 3D volumes in milliseconds.

The proposed surgical workflow is as follows: Use the ICE catheter to take 3D images of the valve and generate a 3D model of the tricuspid valve. Imaging can be done by moving from IVC to SVC and visualizing the right ventricle, tricuspid valve and then the right atrium or by advancing the ICE catheter to the right atrium and imaging the tricuspid valve en face (from above). Using tracked Conavi ICE images, in conjunction with Doppler images, we will derive a model of the regurgitant tri-cusped valve as well as the site of the defect causing re-gurgitation. The next step would be to validate the workflow by navigating the clip, in a phantom model, to the target site and place the MitraClip over the leaflets.

Result: We expect to have an accurate model of the tricuspid valve. Segmentation output will be validated against an expert anesthesiologist's segmentation. The results will also be assessed in terms of inter-user and intra-user variability.

Discussion: This new workflow will help clinicians identify the regurgitation site, decrease their cognitive load and make the surgical procedure both faster and safer. Further work will integrate the Foresight image with 3D TEE to provide additional context for the interpretation of the ICE images.