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Right Ventricular Flow Visualization And Characterization Via High Speed Volumetric Echo-piv

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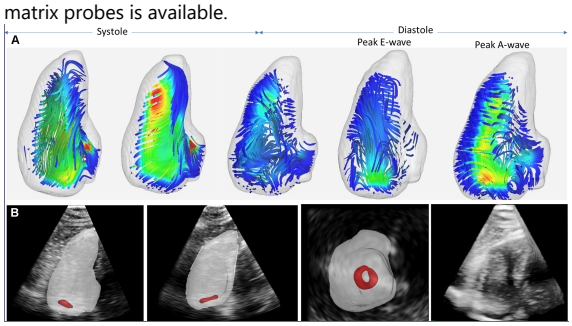
Abstract:
Introduction: Although 4D echocardiography is used for many clinical applications, the evolving vortex flow in the right ventricle (RV) is relatively unknown and cannot be characterized with conventional echocardiography. An obstacle is that acquiring high frame rate (>100fps) data in presence of contrast is challenging and has not yet reported.
Hypothesis: High frame-rate 4D echocardiographic data in presence of contrast can elucidate RV vortex flow via volumetric Echo-PIV (V-Echo-PIV).
Methods: We devised a new transthoracic echocardiography (TTE) protocol using a Philips EPIQ CV9 ultrasound system with a 3D matrix probe (X5-1c) to acquire high frame-rate 4D data for processing with V-Echo-PIV. Apical RV focused view was used for full-volume acquisition by limiting the sector width and imaging depth solely to the entire RV. Visualization of the RV flow and wall dynamics was achieved by IV administration of Optison™ and Normal Saline. VolDICOMs were processed with V-Echo-PIV to obtain RV blood flow velocity field during the full cardiac cycle.
Results: We improve the frame rates' scan lines to +30Hz. A 100Hz is achieved by stitching 4 cycles. We show that 4D RV flow can be quantified and characterized at high temporal resolution using V-Echo-PIV. Fig. 1A shows cine blood velocity in a healthy subject with a 51bpm heart rate. For which, V-Echo-PIV acquired 117 three-dimensional vector fields in one cardiac cycle, given the setting of 100Hz acquisition rate. The figure features flow patterns from systole to diastole, from left to right. Fig. 1B depicts the iso-surface of transient tricuspid vortex during diastolic RV filling.
Conclusions: Enabled by high speed acquition in presence of contrast, V-Echo-PIV can be used as a viable alternative to 4D Flow MRI to visualize and evaluate real-time intra-cardiac blood flow, as it requires only a very short acquisition time and can be used wherever an echocardiography machine with matrix probes is available.



Abstract Graphic/Image Description (Complete):
If you did not upload a graphic/image for your abstract, please type "No image" in the field. (Required) : Top: 3D streamlines of RV blood flow in a cardiac cycle features peak E-wave and A-wave, and vortex flow in systole. Bottom: 3D B-mode images of a RV in full volume, showing the iso-surfaces of vorticity from tricuspid jet at peak E-wave in diastole.
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