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An efficient and reproducible toolset for cardiac MR image analysis

Recent advances in cardiac MR imaging and post-processing capabilities, such as higher spatial-temporal resolution and accelerated cardiac exam workflows, have reinvigorated its use in clinical practice.

To address this growing need, GE Healthcare announced the integration of cmr^{42} cardiovascular post-processing software, licensed from Circle Cardiovascular Imaging (Calgary, Alberta, Canada), onto its GE Advantage Workstation (AW) and AW Server. cmr^{42} is state-of-the-art software that delivers a comprehensive toolset for cardiovascular MR image analysis, including features such as automated contour definition, quick-editing tools and synchronized viewing schemes that simplify tasks commonly done manually. It contains a broad suite of advanced, easy-to-use modules for viewing and analyzing cardiac MR images, including heart function, flow, tissue characterization‡ and T1 mapping‡ and tissue parametric mapping (T2/T2*).

Matthew T. Bramlet, MD, the Director of Congenital Cardiac MR at Children's Hospital of Illinois and an Assistant Professor of Pediatrics at the University of Illinois College of Medicine at Peoria, has been using cmr^{42} as his cardiac MR post-processing software tool for several years. As a pediatric cardiologist, he specializes in children with congenital heart disease, a disease present at birth where structural heart defects involving the heart muscle, valves and/or associated arteries and veins disrupt the normal flow of blood through the heart. For example, blood can flow in the wrong direction or to the wrong place, with varying impact to the patient's health depending on the severity of blood flow disruption. Accurately measuring heart morphology and blood flow is critical for proper diagnosis and treatment planning of congenital heart disease.

Fortunately, since the human cardiovascular system is a closed system of heart and blood vessels, certain cardiovascular relationships must hold true, which offers the possibility of internal validation when performing volume and flow measurements—in other words, the "numbers must match."

"cmr^{42} is valuable because it is an efficient and reproducible tool that allows me to standardize how to validate the numbers I provide in my reports," Dr. Bramlet says.

"When calculating left and right ventricle numbers, I want to have greater confidence in the volumetric analysis and diastolic volumes. By using a reproducible tool, I'm confident that my numbers match."

Dr. Matthew Bramlet

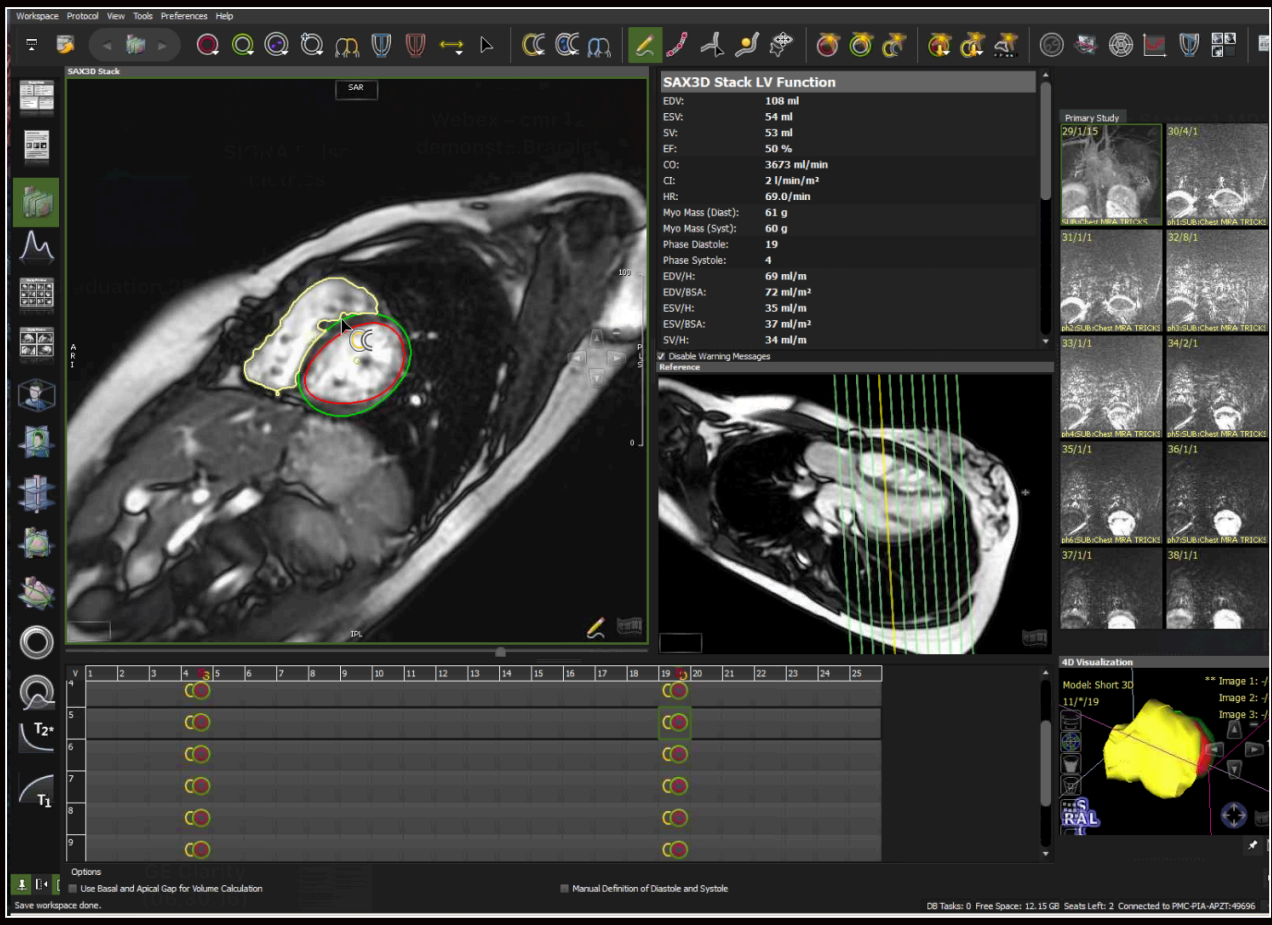

Figure 1. Patient with Tetralogy of Fallot: (A) Using a volumetric short axis cardiac MR image, the clinician draws the contours of the end-diastolic and end-systolic phases.

In particular, the thresholding segmentation contouring tool in cmr[42] is easy to use on congenital exams with a quick "click-n-drag" mouse action that facilitates his ability to achieve the same level of thresholding in each imaging slice, and therefore generates reproducible values. With cmr[42], Dr. Bramlet can apply the threshold and have a high level of confidence that the values are accurate on each slice.

When tracking the endomyocardial border, it is possible to lose the border when a ventricular trabeculation and compaction comes together. Yet, with the thresholding tool, Dr. Bramlet says he can "dive down into where the endocardium is located in a unified fashion, based on minor variations and signal intensity, and feel more confident visually when looking at ejection fraction and the right ventricle that it matches the left ventricle."

In cases of Tetralogy of Fallot, a common congenital anomaly, Dr. Bramlet uses the software to quantify right heart flow and volume. The regurgitant flow fraction measured at the pulmonary valve should match the left and right ventricular volumes. When these numbers do match, he is then confident providing the value to the surgical team for their decision-making process.

As an example, in the case of a 5-year-old patient with pulmonary regurgitation and volume overload on the right ventricle, he uses cmr[42] to calculate the end-diastolic right ventricular volume just before systole. This value is often used by institutions to determine when a patient should undergo pulmonary valve replacement surgery.

"I want to derive that volume not just from a single analysis but one that is validated elsewhere in the patient imaging data," Dr. Bramlet says. "In a typical patient study, in addition to the right and left ventricular analysis, I will

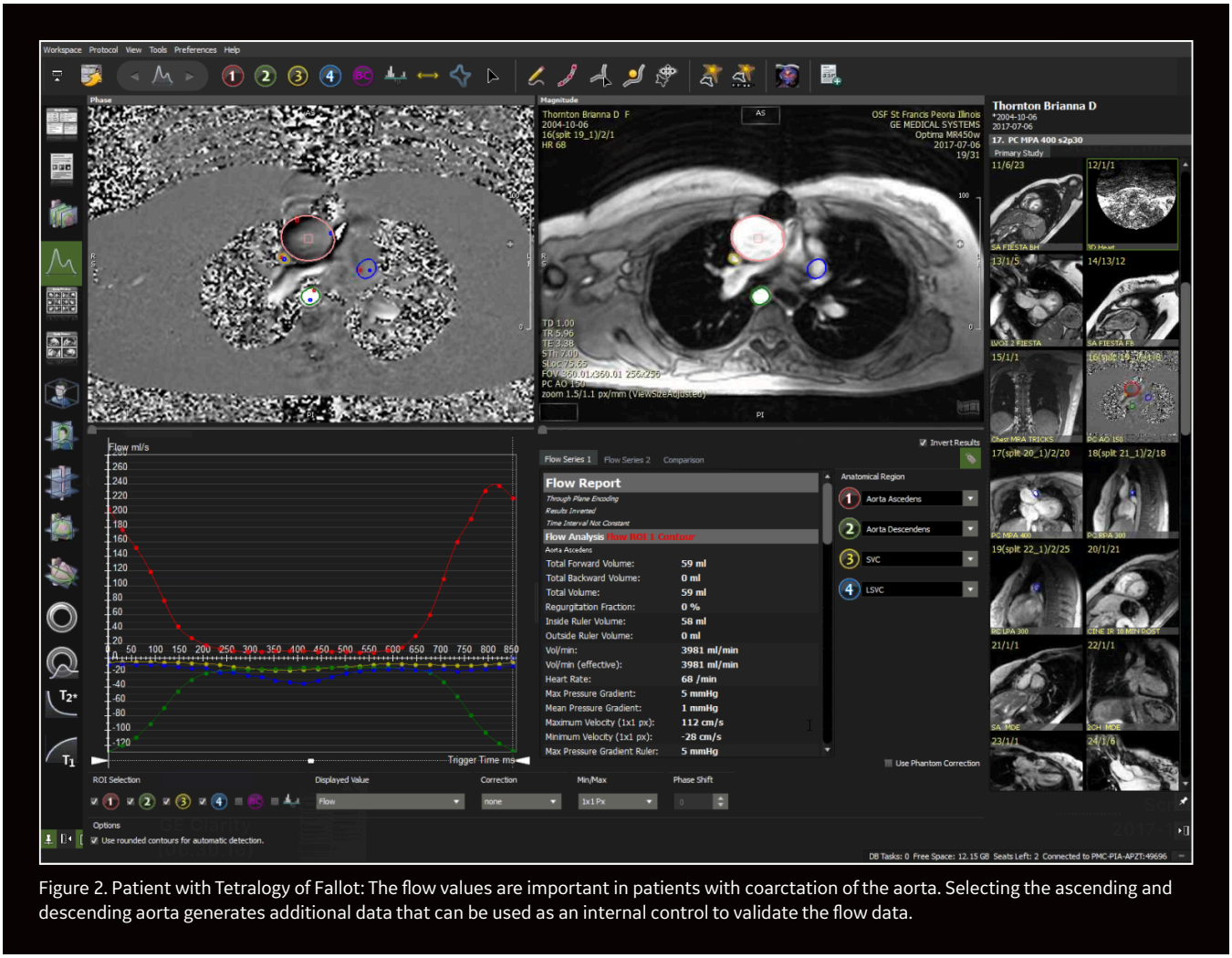

Figure 2. Patient with Tetralogy of Fallot: The flow values are important in patients with coarctation of the aorta. Selecting the ascending and descending aorta generates additional data that can be used as an internal control to validate the flow data.

include aortic and pulmonary phase contrast sequences, which allow me to correlate these values. The regurgitant fraction from the pulmonary valve will frequently relate to the left ventricle and right ventricle. When these values match up, then I am more confident it is a true representation."

Dr. Bramlet finds cmr[42] is not only easier and more reproducible, but it is also faster with more reliable values.

"cmr[42] values are consistent with the clinical picture and easy and efficient to obtain," Dr. Bramlet adds.

In clinical practice, Dr. Bramlet will first launch the 4D viewer for an overview of the case and the volumetric display. He uses the subtracted series from TRICKS and selects a time-resolved image to render (Figure 1). Next, he finds a third subtraction series, and loads the right side of the heart structures for an ideal representation of the organ. He then processes a 3D volumetric map for visualization purposes only (no measurements) and creates a rotating cine image (Figure 2).

"The tools (in cmr[42]) allow me to move faster through the slices and image series, and facilitate movement and actions during the data manipulation so that it is more reliable. I measure the descending aorta every time for extra confidence and by doing that I feel I've gained more knowledge on the patient's condition."

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‡The Tissue Characterization Module is only available for research purposes in the USA since the use of contrast agents for Cardiac MR procedures is not FDA approved, and should not be used clinically.