Editorial for "Evaluation of Cardiac Shunts With 4D Flow Cardiac Magnetic Resonance: Intra- and Interobserver Variability"

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Cardiovascular magnetic resonance imaging (MRI) combined with 2D phase-contrast (PC) MRI is a well-established approach to detect and quantify the severity of intra- and extracardiac shunt defects and its utility is recognized in the clinical workup of patients with atrial or ventricular septal defects or a patent ductus arteriosus.[1,2] Accurate quantitation of the pulmonic-to-systemic flow Qp/Qs-ratio is an important measure in the evaluation of shunt flow, since the timing of surgical intervention is currently based on this ratio. Qp/Qs above 1 indicates shunt flow from the left-sided heart to the right-sided heart, while Qp/Qs below 1 indicates right-to-left shunt flow. Conservative treatment is recommended for asymptomatic patients with Qp/Qs between 1 and 1.5, whereas patients with Qp/Qs of 1.5 and above are usually referred for surgical correction.[3] Assessment of Qp/Qs only at the levels of the aortic and pulmonary valve does not specify whether the location of the septal defect is atrial or ventricular, or—in the case of extracardiac—between the great arteries (ie, patent ductus arteriosus). For such specific information, multiple quantitative flow assessments are required, obtained at the pulmonary veins, ascending and thoracic descending aorta, inferior and superior venae cava, and/or at the atrioventricular valves. 2D PC MRI has been suggested for such an extensive evaluation as well.[4]

However, in the case of concomitant valve regurgitation at either one of the cardiac valves, or for a combination of valves, 2D PC MRI may not be the optimal approach when used for shunt flow calculation. 2D PC MRI uses a static imaging plane that is not adapted to the through-plane motion of the valves during the cardiac cycle. In addition, eccentric flow jets may be missed or misaligned with the acquisition plane, which may lead to underestimation of flow volumes, either for antegrade or retrograde flow, or both.[5,6] Furthermore, by combining measures from multiple 2D PC MRI acquisitions, interscan variations may be introduced that can affect the Qp/Qs calculation. Extending PC MRI towards 3D volumetric acquisition with velocity encoding in all three directions, ie, a 4D flow MRI acquisition, can overcome these limitations of 2D PC MRI. With 4D flow MRI, the time-dependent three-directional blood flow velocity field is registered inside a 3D volume. By applying retrospective valve tracking,[7] transvalvular flow can be quantified accurately, even in the presence of regurgitant jets that are dynamically changing in direction.[6] The net forward flow over each of the four cardiac valves is consistent in subjects without shunt flow,[7,8] and therefore, this technique is clinically very useful for indirect estimation of septal defects. Chelu et al showed the reproducibility of this approach when performed by readers in different centers.[9] The study described in "Evaluation of Cardiac Shunts With 4D Flow Cardiac Magnetic Resonance: Intra- and Interobserver Variability" by Javier et al,[10] published in the current issue of the *Journal of Magnetic Resonance Imaging,* is a feasibility study performed in 18 patients with a confirmed diagnosis of cardiac shunt. The authors used 4D flow MRI to visualize and quantify shunt flow directly at the septal defect and compared these with indirect assessment from the same 4D flow MRI data. Strong intra- and interobserver correlations of direct and indirect assessments were found. Strong correlations were found between Qp/Qs ratio and shunt jet flow volume, diameter, and area. Furthermore, they described good correlations of Qp/Qs ratio, jet volume, area, and diameter assessments with right ventricular volume as possible prognostic associations.

This study extends the findings of the aforementioned study by Chelu et al, whose direct assessment in patients with atrial septal defects established a success rate of 69% of the cases. The current study is the first to explore the direct assessment of shunt flow by 4D flow in a wider range of patients beyond those with atrial septal defects and achieves a success rate of 100% (n = 18) in patients with various shunt pathologies. The results of this study will therefore contribute to the translation of 4D flow MRI into clinical workup of patients with suspicion of cardiac shunt flow, but with the recognition that 4D flow MRI is still associated with long scan times and compromises with respect to spatial and temporal resolution.

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