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EDITORIAL COMMENT

New Era of Measurable Surgical Risk Predictor by 3D Quantitative CT on Pulmonary Venous Return

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Congenital total anomalous pulmonary venous return (TAPVR) is a relatively rare congenital heart disease that can be classified into 3 main types: cardiac TAPVR, where the pulmonary veins return to the heart but not to the left atrium (LA); supracardiac TAPVR, where the pulmonary veins drain into a vein above the heart; and infracardiac TAPVR, where the pulmonary veins drain into a vein below the heart.[1-3] The treatment for TAPVR always involves surgical correction. Except for the cardiac type, TAPVR requires surgical reattachment of the common pulmonary venous confluence (PVC) to the posterior wall of the LA to ensure that oxygen-rich blood is properly directed back into the LA, the left ventricle, and then to the systemic circulation.[4-6]

Because this is a congenital anomaly, newborns are born with this condition, which needs to be addressed promptly. Especially when there is narrowing or obstruction of the return pathway, emergency surgery is often necessary. Even without such narrowing or obstruction, abnormal pulmonary venous return that does not enter the LA can still result in systemic hypoxia secondary to an insufficient oxygenated blood supply to the systemic circulation, a condition necessitating early open heart surgery in infants. This type of surgery, involving small children and the delicate suturing of tiny blood vessels, tests the surgical skills and experience of cardiac surgeons. Postoperative restenosis resulting from intimal hyperplasia of the sutured vessels is a frequent challenge that often requires further intervention. Previous studies of postoperative pulmonary vein obstruction (PVO) in patients with TAPVR have primarily focused on accumulating enough cases to analyze clinical manifestations qualitatively to identify potential risk factors for postoperative PVO, with an emphasis on clinical statistics, such as younger age or mixed-type TAPVR.[7-10]

Shi et al,[11] whose current report is published in this issue of *JACC: Asia,*[11] previously published their innovative methods to extract quantitative data by using computed tomography (CT) scans of patients to analyze the risk of postoperative PVO.[12] Applying the same methodology in this new report to create 3-dimensional models of the LA and the common PVC, Shi et al[11] first calculated the central axes of the anomalous ascending vertical pulmonary vein and each pulmonary vein, thereby identifying the junctions to define the common PVC. They then quantified the distances, lengths, and volumes between both of the 3-dimensional models (LA and common PVC). These parameters were specifically presented in newborns, infants, and young children to disclose their differences, and 2 critical indicators that may lead to postoperative PVO were revealed: smaller total volume of the LA and common PVC before surgery, and shorter length and greater distance of the common PVC from the intended suturing site on the posterior wall of the LA. This is the first time that quantitative data directly support the clinical experience accumulated over the years.[11]

With advancements in computer technology, enhanced computational capabilities, a comprehensive range of fluid dynamics tools, and the digitization of medical imaging, future cardiovascular diseases can be modeled as digital twins through high-resolution medical imaging. The vast amounts of data from these digital human models, combined with the most robust artificial intelligence deep learning technologies, will undoubtedly open new research frontiers. This approach can be applied to individual patients, thus ultimately achieving the

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goals of precision diagnosis and precision treatment as sought by precision medicine.

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