Multidetector computed tomography (MDCT) is a versatile non-invasive advanced imaging modality that has emerged as an essential tool for the assessment and peri-procedural planning of structural heart disease.

With the advent and rapidly expanding use of transcatheter aortic valve replacements, MDCT has become a fundamental requirement for appropriate sizing of valves and in determination of route of access for the procedure. In addition to the annular assessment, MDCT also provides an assessment of the symmetry of the aortic valve leaflets, location and severity of calcifications (e.g. aorto-mitral curtain), left ventricular outflow tract, aortic root, coronary heights, identification of concomitant ascending aortopathy or dissections, and peripheral vascular disease. Moreover, aortic valve CT calcium core can be helpful in assessment of severity of aortic valve stenosis specifically in low flow, low gradient aortic stenosis and can also predict future disease progression [1, 2]. 4D-CT has evolved for the assessment of stenosis/thrombosis post-valve implant.

Significant advances are currently underway for transcatheter mitral valve replacement (TMVR). Although the grade of valvular dysfunction and transvalvular gradients are evaluated by echocardiogram, MDCT is essential for anatomical pre-planning assessment (Figure 1). Currently, MDCT for TMVR is primarily used for cases of valve-in-valve, valve-in-ring, and valve-in-MAC (Figure 2). However, the technology is rapidly evolving to include mitral insufficiency. Our institute is currently a participating center for the Mitral Implantation of TRAnscatheter vaIves (MITRAL) study to establish the safety and feasibility of the Edwards SAPIEN XT™ and SAPIEN 3™ device and delivery systems in patients with severe symptomatic mitral annular calcification disease who are not candidates for standard mitral valve surgery. In addition, our institute is also partaking in the Twelve Transcatheter Mitral Valve Replacement Pilot Study evaluating the Twelve TMVR system in patients with severe, symptomatic mitral regurgitation (Figure 3).

Due to the greater complexity of mitral valve anatomy and the risk of left ventricular outflow tract (LVOT) obstruction, MDCT has a multi-fold utility including assessment of valve and adjacent anatomical structures. Retrospective ECG gated MDCT allows evaluation of the motion of the mitral valve leaflets and annulus. MDCT helps determine the amount and distribution of calcium in an attempt to predict valve anchoring. In addition, MDCT evaluates the features that can predict LVOT obstruction including the more acute aorto-mitral angle [3], the anterior
leaflet length (Figure 4), the size of the left ventricular cavity, the presence of septal hypertrophy, and the change in the residual LVOT space in relation with the depth of valve implantation (Figure 5) [4]. It can also be helpful in planning the site and trajectory of transapical or trans-septal access (Figure 6). Novel MDCT software has been developed which can be used to place “virtual” prosthetic valves of various sizes in the mitral valve position [5, 6]. Modelling of a proposed percutaneous valve at different angles/depths of deployment into the LV allows assessment of the valve fit, protrusion into the LVOT, and likelihood of LVOT obstruction. The measured LVOT area before and after mitral valve implantation can be used to predict risk of obstruction using a formula proposed by Wang et al. [6] (\(\frac{\text{native LVOT area} - \text{neo LVOT area}}{\text{native LVOT area}}\)), although no specific cut point has been identified as of yet. Furthermore, these images can be used for 3-D printing where the proposed valve can be tested physically in the patient's 3-D printed anatomy.

With the increasing interest in minimally invasive tricuspid valve interventions, CT protocols are being developed to specifically assess the tricuspid valve in detail. Similar to TAVR and TMVR, CT may play a key role in peri-procedural planning of transcutaneous tricuspid valve repair. Currently, our institute is one of the centers for the Early Feasibility of the Mitralign Percutaneous Tricuspid Valve Annuloplasty System (PTVAS) Also Known as TriAlign™. (SCOUT) trial. For this tricuspid annular cinching system, assessments of adjacent structures are of particular importance. This includes the right coronary artery, its course through the right aorto-ventricular groove and its distance from the tricuspid valve annulus (Figure 7). Currently, tricuspid valve area is not as well defined. MDCT could be useful in selection of patients with poor echocardiographic windows by more quantitative assessment of RV function and correlation of Tricuspid annular size and EROA compared to echo.

REFERENCES:

Figure 1. Mitral Annular measurements on MDCT a) Cross section of D-shaped mitral annulus; b) Trigone-to-trigone distance; c) Septal-to-lateral distance; d) Inter-commissural distance; e) mitral annular assessment (area/perimeter).
Figure 2. Examples of cross sectional images of mitral valve a) native D-shaped mitral valve annulus in a patient with MR; b) Mitral valve with a ring; c) severe mitral annular calcification (MAC) with MS; d) Prosthetic mitral valve.
Figure 3. Example of a patient who underwent TMVR for severe mitral regurgitation. A) Baseline image showing no MAC; b) post-TMVR long axis image depicting the valve in place and the neo-LVOT; c) cross-sectional image depicting the valve in place and the neo-LVOT.

Figure 4. a) Assessment of anterior mitral leaflet length on MDCT. Assessment of aorto-mitral angle showing b) more acute compared with c) a wider (obtuse) aorto-mitral angle.
Figure 5. Example of a patient with mitral stenosis and septal hypertrophy: A) Pre-TMVR image demonstrating severe septal hypertrophy in systole, which is a significant risk factor for LVOT obstruction after TMVR. B) The aorto-mitral angle was not narrow. This patient underwent septal ablation prior to the TMVR (the yellow arrows point to the ablated myocardium). Post-TMVR, LVOT in three-chamber view in diastole (b) and systole (c). The neo-LVOT is assessed in cross-section images in diastole (d) and systole (e). The gradient across the neo-LVOT was within normal limits on echocardiography (8 mmHg).
**Figure 6.** Assessment of mitral valve trajectory for transapical access.

**Figure 7.** Tricuspid valve assessment on MDCT. It is important to assess the course of RCA adjacent to the tricuspid annulus as shown in the images below. Increased MIP can be used to depict the extended course of RCA around the TV annulus (c).