Case-Based Studies in CMR: Valvular Diseases

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Background
Valvular diseases are among most common cardiac diseases and, depending on their location and extent may have deteriorating impact on cardiac function and thus on patients' morbidity and mortality. Valvular disease may either be congenital or acquired. The set of cardiac valves generally directs intracardiac blood flow in a predefined single direction and failure to do so adequately may either result in non-physiologic backward flow (regurgitation) or limitation of physiologic forward flow (stenosis). Resulting changes in flow lead either to pressure (stenosis) or volume (regurgitation) overload of affected cardiac chambers. Adequate assessment of valvular disease and potential changes in cardiac morphology and function is of utmost importance for proper therapy management and therapy timing. The modality of choice for general screening and by far the most commonly used modality for assessment of valvular disease is echocardiography and Doppler echocardiography. All remaining imaging techniques may be used in dedicated cases or areas of limitation of echocardiography; cardiac MR though is in use more frequently in most recent years (1).

MR Imaging Techniques
Choice of MR imaging techniques mainly focus on the aspects of imaging in valvular heart disease:
- Valvular morphology
- Valvular function
- Effect of valvular disease on cardiac function.
Best suited for assessment of valvular morphology are cine SSFP or sGRE techniques; especially the high CNR of SSFP allows for high spatial and temporal resolution imaging of subtle valvular structures. In order to avoid partial volume effects in assessment of these structures thin slice imaging (3-4mm) is recommended. The assessment of valvular function is based on either cine SSFP or phase contrast (PC) flow imaging. Other techniques may be applied for add-on evaluations or assessment of potential diseases accompanying valvular heart disease.

Valvular Morphology
In regard to the assessment of valvular morphology in MRI descriptions of the identifiable valvular apparatus including leaflets are most important. This includes information on the leaflet/cusp position, variations in numbers, possible fusions and also abnormal structures possibly attached to the valve. The ability of MRI to adequately assess these often subtle structures somewhat depend on the type of valve focusing on (2). In general, MRI is more often in use in regard to morphologic assessment of the ventriculo-arterial valves (Aortic valve, Pulmonary valve) than for the atrio-ventricular valves (Mitral valve, Tricuspid valve)(3). In rare cases MRI is also applied for
differentiation between valvular and sub-/ or supravalvular problems especially in the area of the aortic/pulmonary valves.

Valvular Function
Congenital abnormalities and acquired abnormalities of the valves or adjacent structures (e.g. chambers, vessels) may result in abnormal function of valves such as valve incompetency/insufficiency resulting in blood regurgitation or valvular stenosis with blood flow acceleration resulting in pressure increase/gradients. With cine SSFP/sGRE techniques morphologic assessment of valvular opening areas might be assessed by planimetry (4, 5), phase contrast (PC) flow imaging techniques allow for assessment of velocities with estimation of the peak pressure gradient across a valvular stenosis. However, with 2D PC flow imaging the peak velocity might not be easily identified within a 3D structure such as the aorta or the pulmonary artery and care has to be taken in the choice of sequences (breath-hold/non breath-hold).

In the absence of cardiac shunts and other valvular pathologies with insufficiency, regurgitant volumes and fraction can be calculated by comparison of ventricular stroke volumes or in combination of stroke volumes and forward flows in the aorta or pulmonary artery respectively (6).

When intracardiac shunts or a combination of different valvular pathologies are present, the aforementioned methods typically fail and lead to incorrect results. Direct measurements of transvalvular forward and backward flow using PC flow imaging may then be used for assessment of regurgitant volumes/fraction for triage of the regurgitant severity (7, 8).

Effect on Cardiac Function-Volumetry
Without doubt cardiac MR imaging is the standard of reference in assessment of ventricular volumes (9). Standard cine SSFP techniques will be applied for volumetric assessment of the right and left ventricle, preferable in a short axis orientation (SAO) in for LV volumes and in SAO or axial orientation for RV volumes. With the known high cine MR reproducibility follow-up scanning may allow early identification of functional deterioration and is also considered an important puzzle in the therapeutic decision in valvular heart disease. Assessment of atrial size in cardiac MR could possibly also be performed using cine imaging but most often simple 2D/3D dimensions are assessed.

Conclusion
In general, valvular heart disease is not the immediate focus of cardiac MR imaging, MRI though adds valuable information to other modalities and may be requested especially in ambiguous cases for further therapy decisions. Knowledge on valvular heart disease therefore is of importance. In addition valvular heart disease might accompany other cardiac diseases that are clinically referred to cardiac MRI. Adequate description and classification of such findings is then favoured.

References


