Role of MRI in Patient Selection for CRT

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Introduction: Using current patient selection criteria (NYHA class III/IV HF, LVEF <35%, QRS duration >120 ms, optimal medical therapy for >1 month), 30% of patients undergoing cardiac resynchronization therapy (CRT) with a biventricular pacemaker do not respond positively to the treatment [1,2]. The high non-response rate to CRT, as well as the high cost of the treatment, has motivated investigators to seek new imaging methods to better identify patients who will respond to CRT. Cardiac magnetic resonance imaging (cMRI) has some unique features which suggest that it could be used as a modality to identify patients who will positively respond to CRT.

Use of cMRI to Identify Subjects for CRT: Studies have indicated that at least three factors are important in identifying responders to CRT: 1) the presence of electro-mechanical dyssynchrony [3,4], 2) the presence, size, and location of myocardial scar within the left ventricle (LV) [5,6], and 3) access to an optimal LV pacing lead location via the coronary veins [7,8]. The presence of multiple factors give some clue as to why current selection criteria produces a high rate of non-responders, and also why the recent PROSPECT trial (which used tissue Doppler echocardiography to identify dyssynchrony) failed to improve on the response rate of current criteria [9]. Both current criteria and the PROSPECT trial only looked at measures of electro-mechanical dyssynchrony which is just one of the factors that influence response to CRT.

cMRI can address all three of the previously listed factors that affect response to CRT. cMRI can identify electro-mechanical dyssynchrony using a variety of techniques including cine DENSE [10], tagging [11], tissue velocity mapping [12], and high-frame rate cine imaging [13,14]. All of these methods can produce quantitative measures of the degree of dyssynchrony as well as regional maps of dyssynchrony.

It has been known from previous clinical trials of CRT that patients with an ischemic etiology have a higher non-response rate to CRT than patients with non-ischemic etiology [15]. Recent cMRI studies using late Gadolinium enhancement (LGE) have shown that specifically the scar burden in the LV has a profound effect on the response to CRT. Patients with >15% scar burden have a significantly higher non-response rate compared to patients with non-ischemic etiology [16]. Studies have shown disparate results on the importance of location and transmurality on the response rate, but it is clear that the presence of a large scar burden by LGE is associated with a higher rate non-response to CRT.

Coronary vein anatomy can also be assessed with cMRI. Several groups have presented methods using contrast-enhanced or non-contrast approaches [17,18]. The evaluation of coronary vein anatomy can be used to determine if there is adequate access to a vein in the postero-lateral wall, or determine if veins can access a location of viable myocardium. Placing the LV pacing lead in the postero-lateral wall in an area of viable myocardium has been associated with better response to CRT.

Conclusion and Future Directions: cMRI has some unique advantages as an imaging modality to select patients for CRT. MRI is the only non-invasive modality that can determine
the three factors most often associated with response to CRT: the presence of dyssynchrony, the amount and location of myocardial scar, and the anatomy of the coronary venous structures. Future work includes: combining imaging of all of the factors to better select patients for CRT, understanding the symbiotic relationship of the factors that effect response to CRT, and using imaging to elucidate the underlying electro-mechanical coupling involved in determining patient response to CRT.

References: