Comparison of Echocardiography and MRI for measuring Left Ventricular Mass in the Rat

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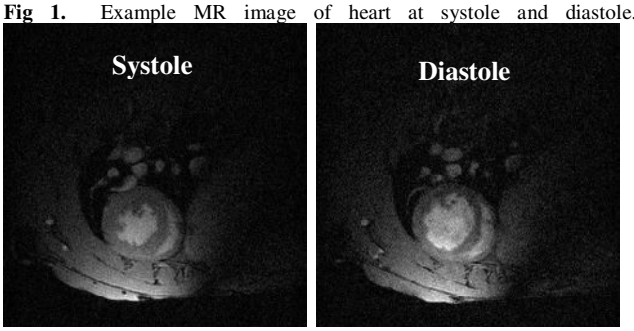
Introduction

Left ventricular hypertrophy is one of the major risk factors for myocardial infarction, congestive heart failure and other cardiovascular disorders. Accurate and early detection of LV hypertrophy is therefore extremely important [1]. MRI has the capability to noninvasively and sequentially measure LV mass and function and has the advantage over the current methods such as echocardiography, in that it provides a 3D image with high resolution. The aim of the present study was to directly compare estimation of LV mass as measured by MRI and echocardiography with the absolute post mortem LV mass values. In addition to this we also measured LV ejection fraction (LVEF) using either multi slice MRI or single slice MRI, similar to echocardiography.

Methods

Rats (n=12) were anaesthetised with halothane in N_2O:O_2 (70:30) prior to imaging. A Bruker 70/30 USR Biospec system with a 32mm diameter surface coil was used for image acquisition with the following parameters: Single slice Flash cine, TE=1.8ms, TR=14ms, Averages=6, field of view=50x50mm, image matrix=256x192mm, flip angle=10°. The entire volume of the heart was scanned by moving the slice by 1mm between acquisitions. ECG gating was carried out using a Biotrig system. MR images were analysed with Paravision v3.0.2. For multi slice MR analysis endocardial and epicardial borders were manually traced to determine LV volumes (for EF) and mass. For single slice MR analysis, posterior and anterior wall thickness and left ventricular internal diameter was measured on 3 short axis images at the level of the papillary muscle similar to echocardiography and the average of these taken. A prolate ellipsoid model was used for determination of EF with single slice MRI analysis. Echocardiographic measurements of posterior and anterior wall thickness and LV internal diameter at diastole were carried out for determination of LV mass.

Fig 1. Example MR image of heart at systole and diastole.



Results

Fig 1 shows a representative MRI image of the heart at diastole and systole. LV mass determined with multi slice MRI analysis (0.751±0.013g) was found to be similar to LV mass measured at post mortem (0.794±0.015g). Echocardiographic estimation of LV mass was significantly higher than post mortem values (1.00±0.03 vs 0.794±0.015g; P<0.05). Similarly, LV mass estimation using only a single slice at the level of the papillary muscle (equivalent to the level used for echocardiography) from MRI also resulted in significantly higher values compared to post mortem LV mass (1.342±0.065 vs 0.794±0.015g; P<0.05) (**Fig 2**). Regression analysis indicated a good correlation between multi slice MRI mass analysis and post mortem mass (r=0.75, P=0.008) (**Fig 3**). Left ventricular ejection fraction was found to be significantly higher when measured using single slice MRI compared to multi slice MRI analysis (60.2±1.7 vs 45.7±2%; P<0.05).

Conclusion

Both MRI and echocardiography are used as non-invasive methods for determining LV mass and function, echo being much more commonly used because of its ease of application and lower cost. We have demonstrated however that multi slice MRI analysis of LV mass provides a much more accurate determination of LV mass compared to echocardiography. This increase in accuracy is due to the ability to obtain a 3D image of the heart with slices through the entire heart compared to the 2D area length formulas of echocardiography [2]. Although ejection fraction was not measured with echocardiography in the current study we did compare single slice MRI with multi slice MRI analysis of EF. We found that single slice MRI analysis (similar to echocardiography) resulted in higher EF values. Since echocardiography results in an overestimation of LV mass it can be assumed that EF is also overestimated. Further studies are required to establish whether such overestimations impact on echocardiography's sensitivity to detect changes with disease.

References

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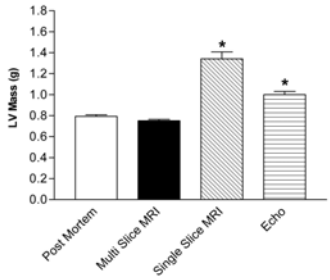

Fig 2. Comparison of Post Mortem LV Mass with LV Mass estimation assessed by either Multi Slice MRI, single slice MRI or Echocardiography (* indicates P<0.05; unpaired t-test).

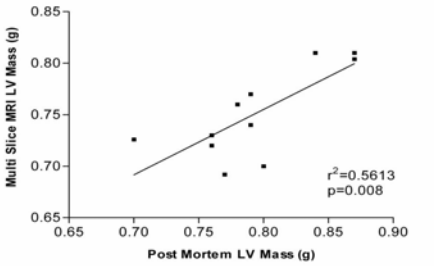

Fig 3. Correlation of Post Mortem LV Mass with LV Mass estimation assessed by Multi Slice MRI.