Relationship of Liver R_2 with Cardiac R_2* in β-Thalassemia

B. Pontre[1], G. Brown[2], W. Chua-anusorn[1], T. St Pierre[1], S. Worthley[3]

[1]School of Physics, The University of Western Australia, Perth, WA, Australia, [2]Department of Radiology, Royal Adelaide Hospital, Adelaide, SA, Australia, [3]Cardiac Catheterization Laboratories, Royal Adelaide Hospital, Adelaide, SA, Australia

Introduction: In the treatment of thalassaemia patients, magnetic resonance imaging techniques have enabled measurements of liver iron concentrations to be made non-invasively. In these patients, the liver iron concentration (LIC) is accepted as the most reliable index of total body iron load, and thus a useful parameter to guide iron detoxification and minimize morbidity. However, this excess iron may be deposited in other organs, in particular the myocardium, where it is responsible for rapidly progressive reduction of cardiac function. Cardiac failure is by far the most common cause of death in these patients. Risk of mortality has been associated with specific levels of liver iron concentrations, though LIC is clearly not the primary determinant of the cardiomyopathy and the full relationship with myocardial iron accumulation remains unclear (1). Previous research suggests that R_2* values in the heart may be indicative of heart iron (2). This research addresses one relaxometry technique to measure R_2* and considers some physical effects that may influence R_2* distribution in the myocardium. The results are also compared with liver R_2 values, a parameter related to liver iron concentrations (3).

Methods: In this study a group of transfusion dependent β-thalassaemia patients managed with sub-cutaneous desferioxamine (n = 19) were scanned with two different relaxometry techniques. Subjects were examined on a 1.5 Tesla cardiac scanner (Siemens Sonata) with advanced IPA and CP body array coil using commercial software. Firstly, a spin-echo sequence was used to obtain a series of single spin-echo axial liver images (TR = 2500ms, TE = 6, 7, 8, 9, 12, 15, 18ms). The subjects were scanned again with 11 ECG triggered segmented GRE sequences in the cardiac short-axis oblique. TR = heart rate, TE = 3.6, 4.6, 5.6, 6.6, 7.6, 8.6, 9.6, 12, 14, 16, 18ms, flip angle = 35°,TD 0 mS, FOV 350 x 350 mm, Matrix 256 x 144, slice thickness 10mm. The images ran through the middle portion of the ventricular septum and included cross sections of the liver and left ventricular cardiac tissue. The segment acquisition period was fixed for all echoes at 186 msec, acquisition occurred at each R wave (TD=0). The images were used to generate a R_2 map of the liver and a R_2* map of the heart septum using a previously reported relaxometry technique (3).

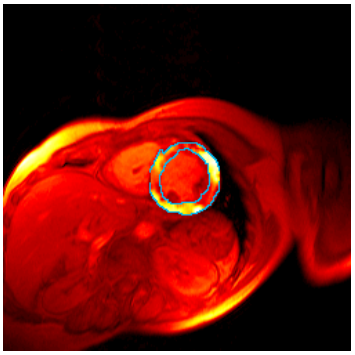

Figure 1 – An example myocardial R_2 map super-imposed on T_2* weighted image*

Results: The results show an inhomogeneous distribution of R_2* values throughout the left ventricle and also within the septum (Figure 1) – a region relatively free of susceptibility artefact (4), and used in other cardiac T2* studies (4,5). A plot of septum R_2* versus liver R_2 is shown in Figure 2. A weak but significant correlation (ρ = 0.598, p = 0.007) was observed between these two parameters using Spearman's Rho statistical test.

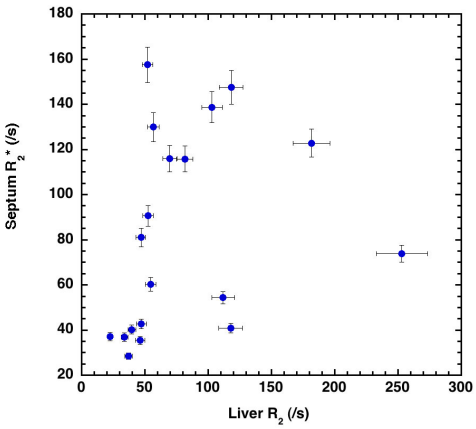

Figure 2 – Plot of mean septum R_2 vs mean liver R_2. Error bars depict literature quoted uncertainties (2,3)*

Discussion: The R_2* increase seen in the left ventricular myocardium appear in locations consistent with previous studies (4), suggesting that such enhancement is due to magnetic susceptibility artefacts caused by the major cardiac veins. It is yet to be determined whether the spatial variations of R_2* within the septum are related to spatial variations in tissue iron concentration or other physical phenomena. Such phenomena may include tissue motion, magnetic susceptibility artefacts or other pathological effects. The correlation observed between liver R_2 and septum R_2*, has not been seen in previous studies (2).

Conclusions: This study shows that there is a correlation between liver iron concentrations and septum R_2*, suggesting that liver iron may be an indicator of heart iron. However, there may be several other factors that determine myocardial R_2* values.

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