Journal of Cardiovascular Magnetic Resonance

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Meeting abstract

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2063 Myocardial T2* estimation techniques in iron overload disease: relationship with Left Ventricular Function

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from 11th Annual SCMR Scientific Sessions
Los Angeles, CA, USA. 1–3 February 2008

Published: 22 October 2008

Journal of Cardiovascular Magnetic Resonance 2008, **10**(Suppl 1):A332 doi:10.1186/1532-429X-10-S1-A332

This abstract is available from: http://jcmr-online.com/content/10/S1/A332

Introduction

Detection of transfusion-induced myocardial iron loading may predict fatal heart failure. Myocardial T2* relaxometry has been proposed as an early measure of myocardial iron accumulation and its implementation by independent laboratories is developing.

Our experience with myocardial T2* has found limited description of the methodology in the literature and has led us to develop explicit rules for data acquisition and analysis with the aim of improving the quality of data that is used to estimate myocardial T2*.

Purpose

We evaluated the impact of these rules on myocardial T2* estimates. Reproducibility of T2* derived from our method was assessed and its relationship with left ventricular function was evaluated.

Methods

Mid septum short axis segmented FLASH images with 11 TE values (3.6–18 ms) were acquired on 30 patients with congenital haemoglobinopathy managed by chronic transfusion and chelation therapy. Mean pixel values at the inter-ventricular septum, were graphed against TE (after noise subtraction). Exponential regression analysis was used to derive T2* values. We compared eleven echo times beginning at 3.6 msec to standard 9 echo times beginning at 5.6 msec as missing early echo times where most change in signal intensity occurs may result in inaccurate exponential curve fitting. Reliability of myocardial signal was assessed by the "noise test" to assure the signal could be reasonably distinguished from background noise. (Myocardial mean – 1 SD) > (Background mean + 1 SD) was required to pass the noise test, otherwise this data point was excluded. The effect of altering methodology on myocardial T2* estimation was assessed by Bland-Altman analysis. Using our methodology, intra-observer variability was performed on 55 scans, inter-observer variability on 30 patients between experienced and newly trained observers and inter-scan variability on 12 patients with scans repeated within 24 hours. Reproducibility was assessed by % coefficient of variation (%CV) and Bland-Altman analysis. Relationship between T2* and left ventricular ejection fraction (LVEF) was assessed by Pearson's correlation.

Results

Observed T2* values were 16.4 ± 12.2 msec (mean ± SD), (range: 4.2–59.9 msec). 9 versus 11 echo times demonstrated a mean difference in myocardial T2* value of -0.4 msec and limits of agreement between -6.2 to 5.4 msec. Of a total of 330 signals analysed, 17 failed the "noise test", representing 5.2% of signals. Failure of noise test involved 8 scans, all with myocardial T2* values < 10 msec. Comparison of myocardial T2* with and without signals failing the "noise test" showed a mean difference of 0.3 msec and limits of agreement between -2.6 and 3.2 msec.

Intra-observer, inter-observer and inter-study %CV were 6.4%, 8.1% and 5% respectively. Mean difference between values (95% limits of agreement) were intra-observer 0.29 msec (-5.0, 5.7 msec), inter-observer 0.5 msec (-3.6, 4.7 msec), and inter-study 0.1 msec (-4.0, 4.2

Table 1: Bland-Altman analysis of intra-observer, inter-observer and inter-study reproducibility

Reproducibility	Mean Difference	95% Limits of Agreement
Intra-observer: all mT2*	0.3 msec	-5.0 to 5.7 msec
Intra-observer: mT2* ≤ 20 msec	-0.08 msec	-3.5 to 3.3 msec
Intra-observer: mT2* > 20 msec	0.8 msec	-6.5 to 8.2 msec
Inter-observer: all mT2*	0.5 msec	-3.6 to 4.7 msec
Inter-observer: all mT2*	0.6 msec	-1.7 to 2.9 msec
Inter-observer: all mT2*	0.5 msec	-6.0 to 7.0 msec
Inter-study: all mT2*	0.1 msec	-4.0 to 4.3 msec
Inter-study: mT2* ≤ 20 msec	0.1 msec	-2.2 to 2.5 msec
Inter-study: mT2* > 20 msec	0.08 msec	-6.9 to 7.1 msec

msec). The Bland-Altman plots also demonstrated direct proportional relationships between its parameters; as the mean of two measurements increased, the difference between the two measurements also increased for intra-observer ($P = 0.003$, $R^2 = 0.266$), inter-observer ($P = 0.03$, $R^2 = 0.16$) and inter-study ($P = 0.018$, $R^2 = 0.446$) Bland-Altman plots. Consequently, Bland-Altman analysis was performed on the myocardial T2* subgroups ≤ 20 msec (abnormal myocardial T2*) and > 20 msec separately for intra-observer, inter-observer and inter-study variability (Table 1). This clearly demonstrated the limits of agreement for abnormal myocardial T2* was narrower than for myocardial T2* > 20 msec. Myocardial T2* correlated with LVEF ($P = 0.026$, $R = 0.421$).

Conclusion

Our myocardial T2* methodology, which included important data points from early echo times and excluded signals with high noise, demonstrates high reproducibility, particularly in the abnormal T2* range (<20 msec), and may have a clinically important effect on myocardial T2* estimates. Its relationship with left ventricular function supports its utility.