

The cardiac triggering time delay is decisive for the spectrum quality in cardiac ^1H MR Spectroscopy

Åsa Carlsson^{1,2}, Maja Sohlén², Maria Ljungberg^{1,2}, and Eva Forssell-Aronsson^{1,2}

¹Department of Medical physics and Biomedical Engineering, Sahlgrenska University Hospital, Gothenburg, Sweden, ²Department of Radiation Physics, University of Gothenburg, Gothenburg, Sweden

Introduction

Localized cardiac MR-spectroscopy (CMRS) is today the only method that facilitates non-invasive localization and quantification of triglycerides stored in the cytosol of the cardiac muscle cells [1], and is therefore an increasingly popular tool for evaluation of the heart metabolism. To receive good spectrum quality in the human myocardium many signal averages are needed and the scanning needs to be both cardiac and respiratory triggered. The time delay of the cardiac triggering is often determined by looking at a dynamic scan of the heart and it can be chosen either in systole, where the ventricular septum is the thickest, or in diastole, where the septum is stationary for a longer period of time. In this work, the spectrum quality related to the choice of cardiac triggering time delay was investigated.

Materials and Methods

The group consists of 5 healthy male volunteers; aged 25-60 years. Imaging and localized proton spectroscopy of the human myocardium was performed using a 5-channel cardiac coil on a 1.5T Philips Intera/Achieva MR system equipped with an MRS research package (Philips Medical Systems, The Netherlands). The spectroscopy scans were respiratory-triggered at end expiration using a pencil-beam navigator [2]. At different cardiac triggering time delays (td), in systole and diastole, non-water suppressed spectra were acquired using point resolved spectroscopy (PRESS) (TE=35ms, TR=6000ms). The volume of interest was 4.5 cm³ and positioned completely within the ventricular septum on short axis and four chamber images. For each td 16 signal averages were acquired as a dynamic series and the water peak of these 16 spectra was separately evaluated using the AMARES algorithm of the jMRUI software [3]. The mean and the standard deviation of the phase, frequency, amplitude and linewidth of these 16 water spectra were determined and compared for different cardiac triggering time delays. At two selected td , one in systole and one in diastole, water suppressed lipid spectrum were acquired (TE=35, TR=3000, 128 signal averages).

Results

Visual inspection of the two lipid spectra clearly shows more signal and better quality of the spectra acquired in systole (Fig. 1). Comparing the quality parameters of the water spectra no relation was found between the phase, frequency or the linewidth of the water peak and the cardiac triggering time delay. However, the standard deviation of the phase and linewidth was strongly dependent on the chosen td (figure 2a-b). Also, the amplitude and the standard deviation of the amplitude were related to the td (figure 2c-d). An optimal td with high amplitude and low standard deviations was found at td of about 25 % of a full cardiac cycle.

Discussion

To get enough signal-to-noise ratio in cardiac spectroscopy many signal averages are needed. If there is a deviation between the signal acquisitions the final spectrum quality will be degraded and low standard deviations for the signal averages are thus essential. A variation in phase will cause a poor signal summation, possibly even signal cancellation. Minimal phase variation and maximum amplitudes were found in end-systole, at a cardiac triggering delay time around 25% of the total cardiac cycle (Fig. 2). It can also be seen how the spectrum quality dramatically deteriorated later in end-systole so it was better to choose a trigger time delay that was a bit too early compared to choose one that was too late. Every volunteer had an individual optimum that easily could be found by comparing several non water suppressed signal averages at different time delays.

Conclusion

The spectral quality in cardiac spectroscopy is strongly dependent on the cardiac triggering time delay. The best spectral quality can be anticipated from spectra cardiac triggered to end-systole at about 25% of the full cardiac cycle. However, for optimal spectrum quality the cardiac triggering time delay should be individually optimised.

References

- [1] McGavock J.M. et al. (2007) *Circulation* 116(10): 1170-1175.
- [2] Kozerke S. et al. (2002) *Magn Reson Med* 48(2): 380-384.
- [3] Naressi A. et al. (2001) *MAGMA* 12, 141-152.

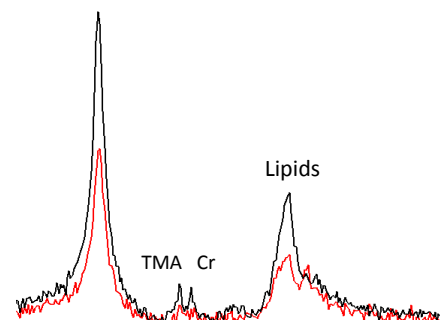


Figure 1. Two ^1H MR spectra from the ventricular septum in the same volunteer. The black spectrum is acquired in systole and the red one is acquired in diastole.

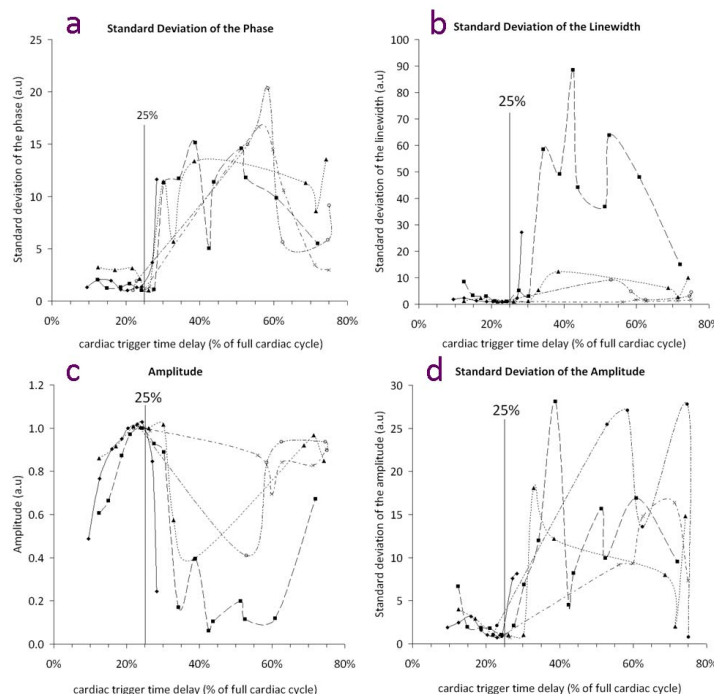


Figure 2. Spectrum quality parameters for different cardiac triggering time delays (td). a) Standard deviation of the phase. b) Standard deviation of the linewidth. c) Peak amplitude. d) Standard deviation in the peak amplitude.