

Impact of Timing and Dose of Isosorbide dinitrate Administration on Coronary MRI

P. Hu¹, D. C. Peters¹, K. V. Kissinger¹, B. Goddu¹, L. Goepfert¹, W. J. Manning¹, and R. Nezafat¹

¹Beth Israel Deaconess Medical Center, Boston, MA, United States

Introduction

Despite technical progress, coronary magnetic resonance imaging (MRI) still faces multiple challenges including low SNR and small vessel size. Coronary vasodilators, such as sublingual nitroglycerin (NTG) or longer acting nitrates (e.g., isosorbide dinitrate), are commonly used to study coronary circulation. Terashima et al. [1] reported on the impact of sublingual NTG on coronary MRI. Isosorbide dinitrate (Isordil) has been previously reported in a multi-center clinical coronary MRI trial [2]; however no data have been provided to quantify coronary MRI image quality improvement and time course of the effect of isosorbide dinitrate. In this study, we investigated the impact of sublingual isosorbide dinitrate administration on SNR, vessel diameter, vessel sharpness and overall image quality in coronary MRI as a function of time, dose and imaging sequence.

Materials and Methods

Coronary MRI was acquired on a cohort of 20 healthy adult subjects using a 1.5T Philips Achieva CMR system and commercial 5 element cardiac phased array coil. Subjects were divided into four groups to investigate the impact of the imaging sequence and dose of isosorbide dinitrate. In groups A and B the images were acquired using SSFP imaging sequence with either a 2.5 mg or a 5mg dose of isosorbide dinitrate. In groups C and D, images are acquired using GRE with either a 2.5 mg or a 5mg dose. The time course of the effect of isosorbide dinitrate was studied by repeated imaging after a baseline (pre-drug) acquisition. A free breathing, 3D ECG triggered GRE sequence with typical imaging parameters of $TE/TR/\alpha=2.2/7.7/30^\circ$ with spatial resolution of $0.7 \times 1 \times 1.5 \text{ mm}^3$ reconstructed to $0.52 \times 0.52 \times 0.75 \text{ mm}^3$ was used. The imaging parameters for SSFP imaging included: $TE/TR/\alpha=2.3/4.6\text{ms}/90^\circ$, spatial resolution of $1 \times 1 \times 1.5 \text{ mm}^3$ reconstructed to $0.52 \times 0.52 \times 0.75 \text{ mm}^3$ and a half α preparation pulse. T_2 prep, fat saturation and right hemidiaphragm navigator sequences were used in both sequences. Coronary MRI acquisition was repeated continuously after isosorbide dinitrate administration for 45 minutes.

All images were transferred to a stand-alone PC for analysis. SNR was measured as the mean blood signal in the proximal coronary artery divided by standard deviation of air [3]. To be consistent, the same noise and signal ROI's were used in all the GRE and balanced-SSFP scans during a study, unless motion is detected between the scans. The coronary cross-sectional diameter in the proximal right coronary artery (RCA) and vessel sharpness were measured using the Soap Bubble tool (Philips Healthcare, Best, NL) [2]. The percentile change in SNR and vessel sharpness was calculated by normalizing each value to the ones from pre-isordil acquisition.

Results

Figure 1 demonstrates the improved coronary MRI 10-15 minutes after Isordil administration. The vasodilation and signal enhancement help better delineate and differentiate the RCA (arrows). The visibility of distal branches of RCA was improved (arrow heads). Figure 2 shows the SNR enhancement at five different time intervals after isosorbide dinitrate. The maximum SNR increase was $21.5\% \pm 9.3\%$ for GRE with 2.5mg dose, $22.5\% \pm 12.3\%$ for GRE with 5mg, $19.7\% \pm 3.1\%$ for SSFP with 2.5mg and $19.1\% \pm 6.0\%$ for SSFP with 5mg. The maximum SNR enhancement occurs earlier (17 min) following the 5mg dose (26 min). There was a $>15\%$ increase in vessel lumen diameter throughout the 5 post-Isordil scans, with a $>20\%$ increase in all but the first time point. Figure 3 shows the RCA vessel sharpness score. For both GRE and SSFP sequences, the 5mg dose isosorbide dinitrate dose results in greater vessel sharpness compared to 2.5mg.

Conclusion

Sublingual isosorbide dinitrate administration improves coronary MRI SNR by 20% for both GRE and SSFP imaging. Compared to 2.5mg dose, a 5mg dose results in comparable vasodilation but with an earlier onset and greater vessel sharpness scores. For best SNR enhancement, the timing of coronary MRI image acquisition should be adjusted based on the dose of sublingual isosorbide dinitrate, with later imaging if 2.5mg dose is used.

References

[1] Terashima, JACC 2005;45(1):104-110, [2] Etienne, MRM 2002;48:658-666, [3] Botnar, Circulation 1999;99:3139-3148.

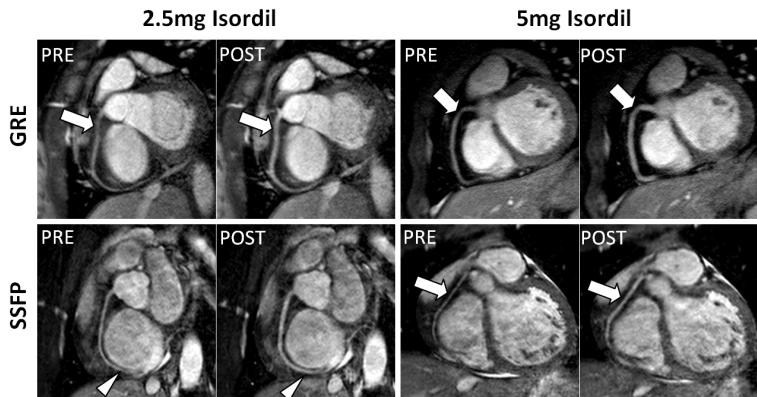


Figure 1: Examples of pre- and post-Isordil images from four subjects using combinations of two different sequences (GRE and SSFP) and two different Isordil doses (2.5mg and 5mg) at 10-15 minutes after Isordil.

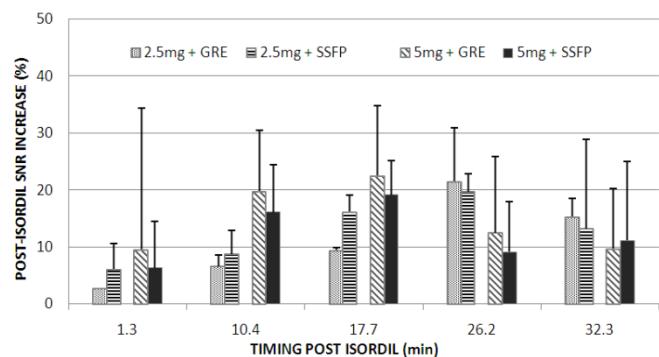


Figure 2: The time course of SNR increase with successive coronary MRI acquisitions after Isordil administration using the GRE and SSFP sequences.

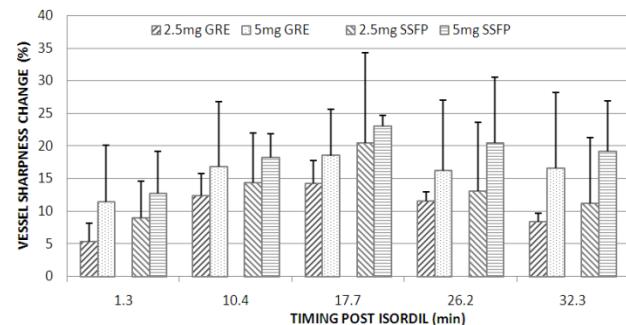


Figure 3: The time course of vessel sharpness increase after Isordil administration using the GRE and SSFP sequences. For both GRE and SSFP sequences, the 5mg dose resulted in greater vessel sharpness (vs. to 2.5mg). For the same dose, GRE and SSFP result in comparable increase in vessel sharpness.