Changes in Coronary Sinus Size throughout the Cardiac Cycle: Implications for Coronary Vein Imaging

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Introduction

Assessment of coronary vein anatomy in patients undergoing cardiac resynchronization therapy could facilitate the transvenous left ventricular lead placement. Cardiovascular MR imaging has the potential for imaging the coronary veins non-invasively. In coronary MR vein imaging, the image data is acquired during the quiescent period in cardiac cycle to minimize blurring due to cardiac motion. On one hand, there are two quiescent periods, a shorter early systolic period and a longer late diastolic period available for image acquisition. On the other hand, the diameter of the coronary sinus and its tributaries vary throughout the cardiac cycle [1]. The variations in diameter of the coronary veins during cardiac cycle could affect the required image voxel size and visibility of the veins. The most desired imaging period in the cardiac cycle is the time during which the vessel is fully dilated and overlaps with the quiescent period. In this study, we present preliminary results of variations of the coronary sinus size and its implications for coronary vein imaging.

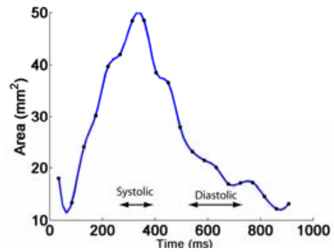

Figure 1: Coronary sinus cross-sectional area during the cardiac cycle in a healthy subject. There is significant change in the size of the coronary sinus during cardiac cycle.

Methods:

A free breathing, vector ECG gated, coronary MR vein imaging sequence, analogous to the one used in coronary artery imaging [2] is developed. For coronary vein imaging, a magnetization transfer pre-pulse [3] is used rather than T_2 prep in order to retain deoxygenated blood signal.

Images were acquired in 5 healthy adult subjects on a 1.5T Achieva (Philips Medical Systems, Best, Netherlands) with a 5-element cardiac coil. Three-orthogonal stacks of multiple 2D bright blood images were acquired for localization and navigator positioning using SSFP sequence. Subsequently, vector ECG triggered, segmented SSFP cine images were acquired in a 2 chamber view to produce a cross sectional view of the coronary sinus in the plane. The onsets and durations of the 2 quiescent periods, one in end-systole and one in late-diastole, were determined visually. Two 3D axial, navigator gated, free breathing, MT prepared (8 RF, frequency=300-500Hz, α=800^0-1000^0, duration=15-20ms) scans were acquired during each of the two quiescent period for localization of the coronary veins. Subsequently, the volume for coronary vein MR imaging was prescribed using a 3 point planning tool in both the diastolic and systolic phase using the appropriate low resolution localizer scans. The imaging parameters were as follows: *TE=1.9ms, TR=6.1ms,* α= 30^0, 1×1×3mm^3 reconstructed to 0.53×0.53×1.5mm^3, 10 RF per cardiac phase. Cross-sectional area of the coronary sinus is measured from the 2 chamber view using commercial Viewforum software (Philips Medical Systems).

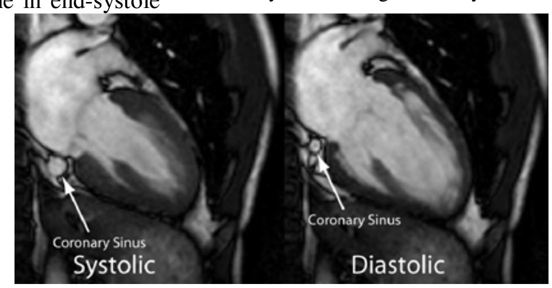

Figure 2: Coronary sinus images during systolic and diastolic cardiac phase. An increase in diameter of the coronary sinus can be seen.

Results:

Figure 1 shows the changes in the cross sectional area of the coronary sinus during the cardiac cycle. Figure 2 shows a 2 chamber view comparing the diameter of the coronary sinus acquired during the early systolic phase compared to the late diastolic phase. Figure 3 shows the images of the posterior branch of the coronary venous anatomy in a different subject. These images show the increase in the vessel size during the systolic period.

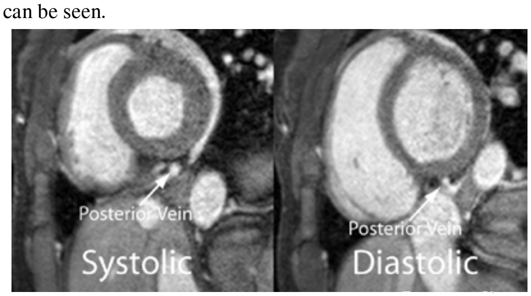

Figure 3: Images of the posterior coronary vein acquired during systolic and diastolic quiescent periods. The diameters changes from ~3mm in diastole to ~7mm in systole.

Conclusion

MR images of the coronary veins can be acquired during either the systolic or diastolic quiescent period. We have observed a 2 to 4 fold increase in coronary vein size during the systolic phase. This increase in the vessel size allows better delineation of the coronary sinus tributaries. Although the systolic quiescent period is typically shorter than the diastolic period [4], systolic imaging may still be more robust.

References: [1] van Rossum et al., Radiology, 182 (3): 685. 1992 [2] Kim WY, N Engl J Med. 2001 Dec 27;345(26):1863-9. [3] Wolff, MRM. 1989 Apr;10(1):135-44. [4] Johnson, JCMR 2004,(3)-663-673.