Journal of Cardiovascular Magnetic Resonance

Meeting abstract

1052 The settling properties of slow flow blood demonstrated using SWI

Ewart M Haacke*, Samuel Barnes, Zahid Latif and Jaladhar Neelavalli

Address: Wayne State University, Detroit, MI, USA
* Corresponding author

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):A177 doi:10.1186/1532-429X-10-S1-A177

This abstract is available from: http://jcmr-online.com/content/10/S1/A177

Introduction

For some time now it has been possible to measure oxygen saturation with susceptibility weighted filtered phase imaging. However, when the subject has slow flow this method often fails. We postulate that this is due to the settling of blood in some veins when the flow is slow.

Purpose

To demonstrate that blood separates into at least two separate components, hematocrit and plasma, and possible a third layer which is a mixture of both.

Methods

We use an SWI sequence to obtain both magnitude and phase images. High resolution scans are used (with a resolution of 0.5 mm × 0.5 mm in-plane, 2 mm slice thickness) in a transverse plane to image the calf. No cardiac gating is performed. The phase images are filtered using a 64 × 64 central k-space homodyne filter. In six cases, the TR was 60 ms and the TE was 40 ms, in three cases, the TR was 20 ms and the echo time 10 ms. Scan times were 8 minutes for the shorter TR and 64 slices and 12 minutes for the longer TR and 32 slices. No parallel imaging was used. A total of 9 volunteers were scanned with an age range of 18 to 56. One patient was scanned in both the supine and prone position. The rest were scanned in the supine position.

Results

The phase was found to vary in an unexplained way for the first 7 subjects. There were variations in venous signal intensity, T2* and phase. In the last two, a father/son matched pair, the son showed no artifacts, while the father showed major artifacts. The son had small vessels with rapid flow while the father had veins twice the diameter. This led to dramatically reduced speeds in the large vessels. Figure 1 shown below represents the vessel cross sections in the prone state (left hand side) and in the supine state (right hand side). The latter was acquired 20 to 28 minutes after the subject was placed into the magnet. The difference in these images clearly shows the separation into at least two, if not three, distinct layers. The younger subjects showed no such separation and usually had smaller veins than the older subjects. Finally, in many cases it was possible to visualize the arterial and sometimes venous vessel walls.

Conclusion

The separation of the blood into different layers after only 20 minutes has major implications. The more dense hematocrit sinks as the blood flow from certain vessels seems to be naturally reduced and shunted to other vessels. The implications of this to deep venous thrombosis are that blood settling may serve as a risk factor or predictor. This remains to be validated, but the separation of the blood is already in itself a major new rheological, hemodynamic and hematological finding.

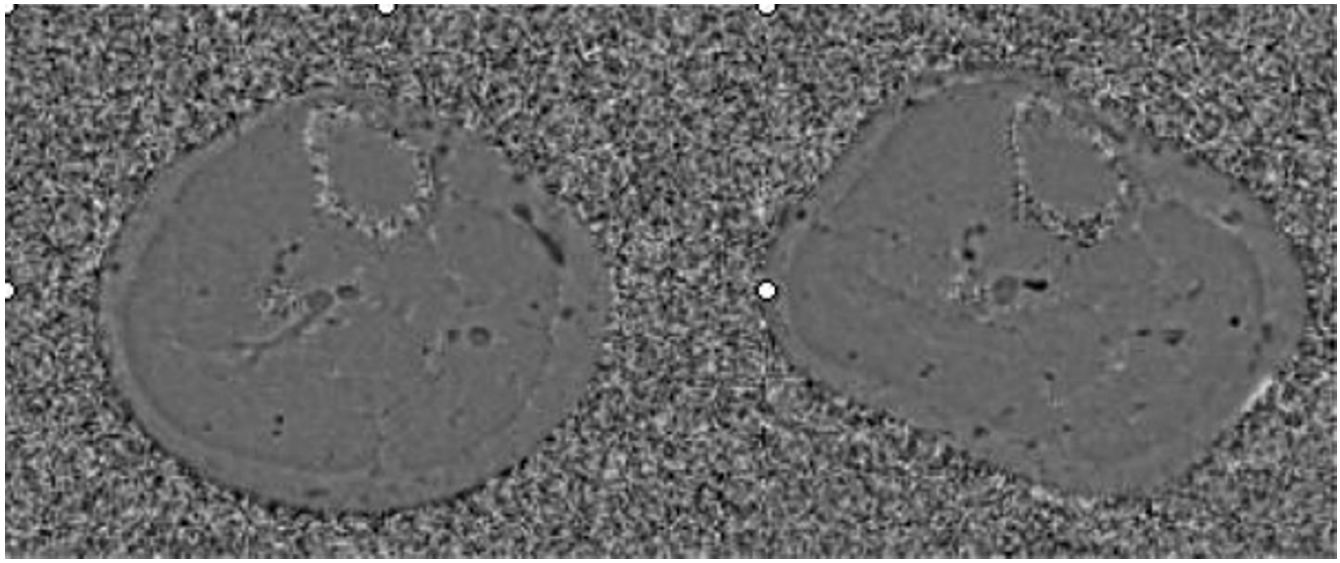

Figure 1
Using SWI, we show for slow blood flow in the peripheral vasculature that blood separates into plasma and hematocrit. This may serve as a risk factor for DVT. SWI is shown to reveal the vessel wall in its pristine state.