Magnetic Particle Imaging (MPI) Opening New Possibilities in Perfusion Imaging

Standard Perfusion Imaging

There is a need for more effective diagnostic perfusion imaging approaches for diseases such as stroke. It is well known that perfusion imaging, combined with a means of altering cerebral perfusion pressure or cerebrovascular resistance, can measure a patient's cerebrovascular reserve and predict the risk of stroke [1]. However, current neurovascular imaging techniques suffer from limitations in radiation exposure, safety, speed, sensitivity and specificity that prevent their use in measuring cerebrovascular reserve [2]. New neurovascular imaging techniques for the diagnosis, staging, and monitoring of acute stroke and sub-acute stenoses, arterial-venous malformations (AVMs) and aneurysms, among others are desired.

Gains such as a reliable and non-invasive neurovascular stress test, similar in concept to a cardiac stress test, would revolutionize cerebrovascular imaging and stroke prevention. With the emergence of MPI many of these previously unattainable characteristics of perfusion imaging could be possible.

MPI Perfusion Imaging

MPI is a new imaging technology that answers a clinical need for a safe, rapid 3D perfusion and 3D angiography technique without ionizing radiation or toxic tracers to image intracranial diseases such as stenosis (stroke),

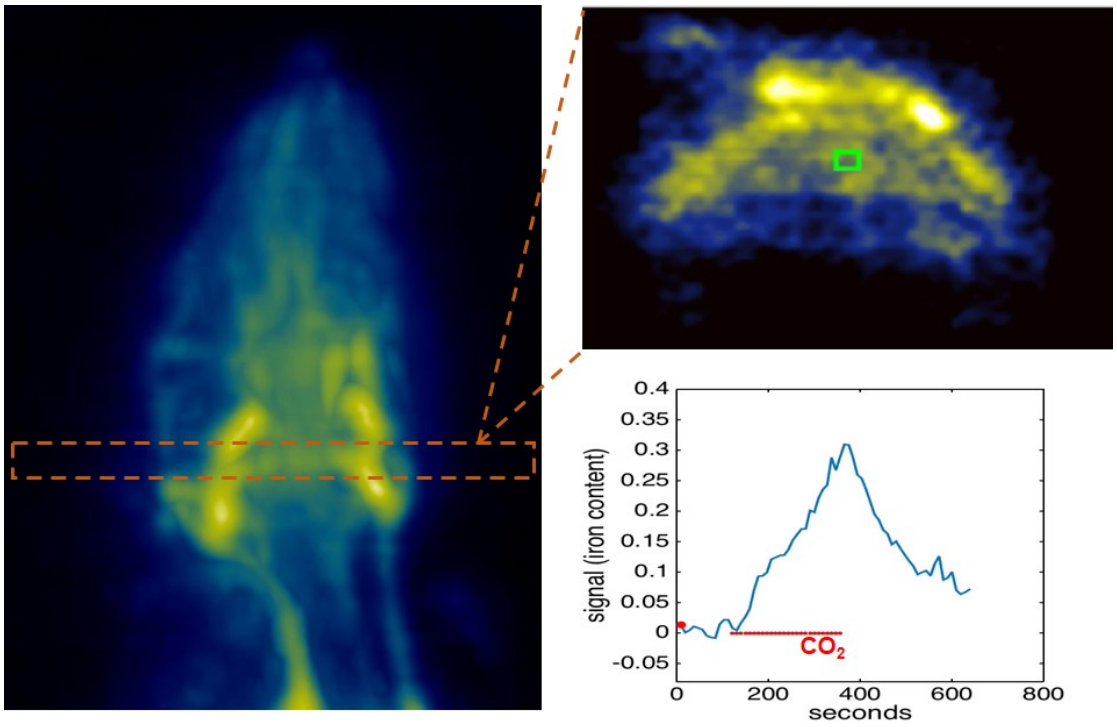

Figure 1: Blood pool imaging shows vascular architecture and can be used to make dynamic blood flow measurements.

aneurysm, vasospasms and malformations [3]. Stroke diagnosis is typically done using CT Angiography (CTA) and MR Angiography and treatment, if necessary, is performed using minimally invasive surgical techniques or neurosurgery. MPI scans can be acquired in real-time and have a similar work flow to CT [4]. This approach, which combines the speed, ease of use and image quality of CT with the high-image contrast of nuclear medicine. The MPI technique "sees" the superparamagnetic iron oxide (SPIO) nanoparticle tracer using their non-linear response to non-ionizing magnetic fields [5,6]. The MPI tracer is significantly safer than Iodine (used in CT and fluoroscopy), and Gadolinum (used in MRI) that can be contraindicated in patients with chronic kidney disease [7]. Therefore, MPI is able to perform quantitative angiography and perfusion without risk of patient injury. MPI produces absolutely no signal from overlying tissues creating positive contrast images or real-time perfusion with unprecedented contrast-to-noise and signal-to-noise. The high contrast tracer imaging enables simultaneous assessment of blood vessel lumen diameter and quantitative perfusion imaging (Figure 1). In this example, a rat was administered with SPIOs intravenously and subjected to a CO2 challenge. This stimulus promotes a transient change in blood volume moving through the vasculature. The images shown are quantitative and were acquired in real-time. Regions of interest can be selected anywhere in the brain for blood volume measurements.

Conclusion

MPI excels in blood pool imaging, enabling new approaches for quantitative real-time perfusion and functional brain imaging and enabling stroke and traumatic brain injury studies. Further, the technique has the potential for use in radiation-free interventional procedures, and is compatible with established clinical workflows.

References

1. Stroke. 2013 Sep; 44(9): 2628–2639

2. Stroke. 2003 Apr;34(4):1084-104

3. Int J Nanomedicine. 2015; 10: 3097–3114

4. Stroke. 2016 Mar;47(3):695-700

5. Theranostics. 2016 Jan 1;6(3):291-301

6. J Magn Reson. 2013 Apr;229:116-26

7. Adv Mater. 2012 Jul 24;24(28):3870-7

magnetic INSIGHT

1010 Atlantic Ave. Suite 100
Alameda, CA 94501, USA
info@maneticinsight.com
magneticinsight.com