Due to the heart’s location in the thorax, surrounded by inhomogeneous tissue structures, and its on-going motion, up to now precise cardiac Magnetic Resonance Imaging (MRI) has presented a technical challenge for researchers. However, since 2006, when Hans-Ulrich Kauczor and colleagues at the Erwin-Hahn Institute of Magnetic Resonance Imaging and Functional MRI, Charité, Berlin, published their first results, cardiac MRI has become an almost indispensable technique.

As reported in our Online-Edition (www.european-hospital.com 11/12/09) Professor Mark E Ladd (www.european-hospital.com) has now been tackling the heart’s location for a long time. This is due to the heart’s location being a black hole for MRI and other imaging modalities. To exclude the interference of cardiac motion and heart rate variability on cardiac MRI contrast images, the ECG and the cardiac trigger signal need to be accurate. This makes the ECG triggering as an essential part of any cardiac MRI examination, and has the potential to advance cardiac MRI at 7-T. Developed by researchers at the Experimental and Clinical Research Centre (ECRC) in Berlin-Buch, Germany, the new technology will soon enable cardiac characterisation at tissue-level and promises to bring new insights into cardiac function and myocardial (patho-)physiology.

**Cardiac MRI at 7-Tesla**

During conventional electro-cardiology, interference from electromagnetic fields (EMFs) tends to diminish image quality due to cardiac motion. To exclude that interference an acoustic cardiac triggering (ACT) approach, also called MR stethoscope, has been developed to trigger cardiac MRI at 7-T. Developed by researchers at the Experimental and Clinical Research Centre (ECRC) in Berlin-Buch, Germany, the new technology will soon enable cardiac characterisation at tissue-level and promises to bring new insights into cardiac function and myocardial (patho-)physiology.

The MR-Stethoscope consists of four elements: an acoustic sensor, acoustic waveguide, signal processor and a coupler linked to the MRI system. The chest-piece is a common piece of a stethoscope, when located on a patient’s chest the acoustic sensor registers cardiac sounds. In a specially developed procedure the acoustic signals are transformed into a trigger signal, mimicking the basic waveform of an ECG. The MR-Stethoscope is compatible with both MRIs and does not need any hard- or software changes.

A first clinical study (published: European Radiology online) showed proof of concept by comparing left ventricular function assessment using ECG and ACT triggered MR-Imaging at 1.5-T and 3-T. Meanwhile, Prof. Niendorf and Prof. Schulz-Menger’s team studied the feasibility of acoustic triggering at 7-T using a whole-body human MRI scanner with an 8-channel transmit-receive system at the Berlin Ultrashield Field Facility (B.U.F.F.). They received exciting results: ‘We achieved reliable and accurate CINE images of the beating heart with sharp contours. We can ensure, at 7-T, the standard we know from MR-Imaging at lower magnet fields. Testing the different methods the failure rate with ECG-triggering at 1.5-T came to a negligible 5% but, at 7-T, the rate was 40%. However, the MR-Stethoscope eliminated those failure rates,’ said Prof. Niendorf.

Prof. Schulz-Menger added: ‘With appropriate radio frequency coils and triggering devices in place we hope to achieve a kind of mini MR-stethoscope. In other words, we will examine and characterise the myocardial tissue with, up to now, unmatched precision. We are already achieve an in-plane spatial resolution of 1mm², together with slice thicknesses of 1.25mm in the 7-T scanner. You can even see subtle anatomical features, such as the characteristic “endovascular” leaflet in the mitral valve, in great detail, all in a non-invasive way, excluding harmful radiation exposure.’

According to Hans-Ulrich Kauczor, MR stethoscope at 7-T is expected to advance the ability to differentiate myocardial and pericardial diseases, such as fibrosis, and to monitor disease processes. Considering the development of the stethoscope, Prof. Niendorf pointed out: ‘By reminding us that previous diagnostic technologies and equipment in this area continues to lead us into the heart of the matter.’

Worldwide, 7-T scanners are still confined to research; they are not licensed for clinical use. ‘The MR-stethoscope is currently too expensive for clinical use: the 7-T system at B.U.F.F., for example, costs around €8 million. Despite these constraints, Prof. Niendorf and Prof. Schulz-Menger are convinced that their research will bring important knowledge of how cardiac structure and cardiac disease processes – all of which could help to develop new diagnostic strategies and therapies.’

**Report: Bettina Debeyreux**