

First Clinical Experiences with a Prototype* of a Novel Cardiac Workflow Engine

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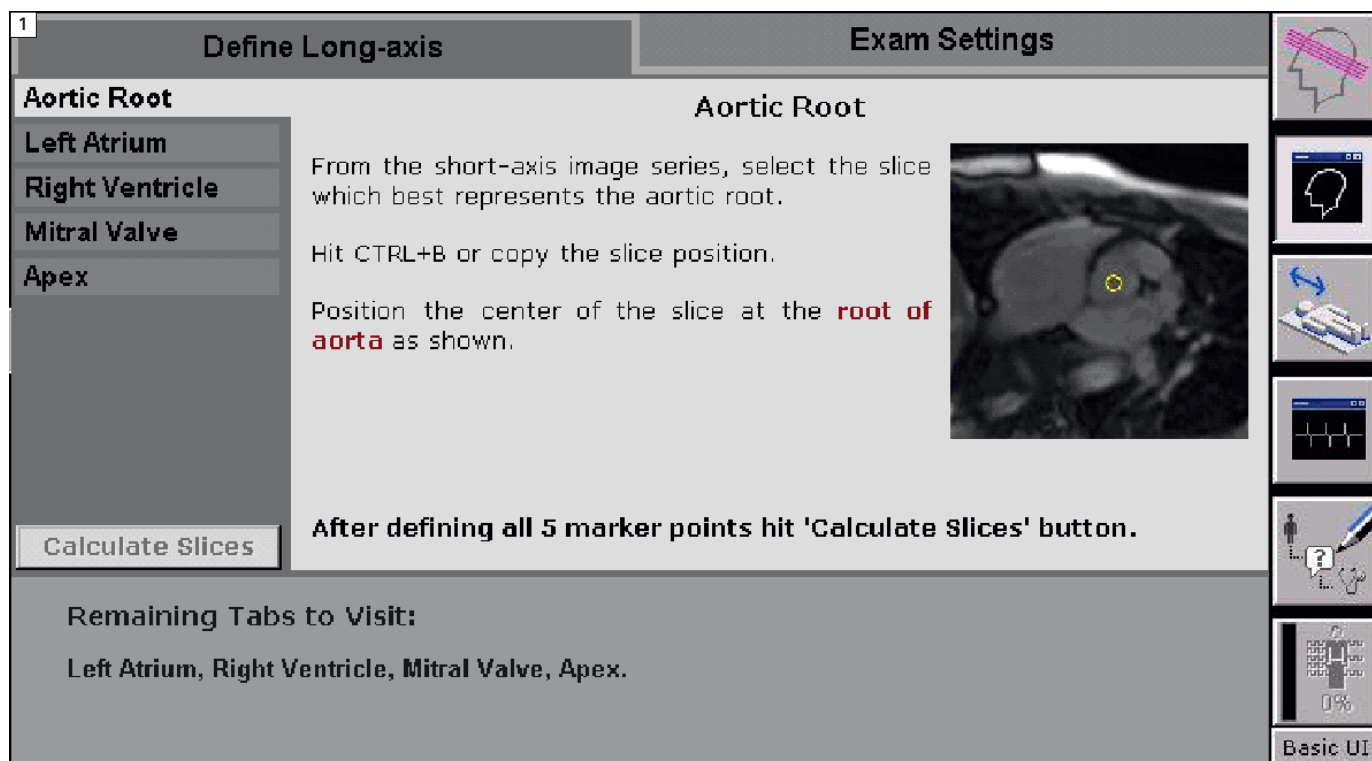
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Introduction

In November 2007 a novel cardiac work in progress (WIP) software package was introduced on our 1.5T Siemens MAGNETOM Avanto MRI system (high-order shim, 32-channels, SQ gradients). This WIP system automates or augments most user interactions during cardiac scanning. For localization of standard cardiac planes users select anatomical

reference points on the heart, supported by guidance images and text (Fig. 1). The software then calculates all cardiac planes automatically and applies them to all subsequent measurements. Sequences are automatically adapted to the patients heart rate and breath-hold capability according to the exam settings entered by the user (Fig. 2).

The field-of-view is automatically adjusted for each combination of planes to fit the individual patient. Reliable, robust protocols can be constructed ensuring a comprehensive cardiac exam but still allowing enough flexibility to add additional sequences such as flow, tagged grid, constriction tests, etc.



1 Novel way of localization of the heart: The user marks five anatomical landmarks. To find the landmarks, guiding text and example images are displayed. These landmarks are consecutively used to calculate all cardiac planes.

2

Define Long-axis

Breathhold Duration sec







Captured Cycle

Predicted R-R Cycle ms

Exam Settings

Trigger Source

These settings will be applied to the complete exam.
 If the patient heart-rate varies significantly during the scan, enter a predicted value of R-R cycle to optimize the protocol for scan conditions. Otherwise, leave this field blank.

Basic UI


2 Exam Settings – Patient-centric parameters which globally influence the whole exam and are used to initialize the scan protocols.

3

Localizer

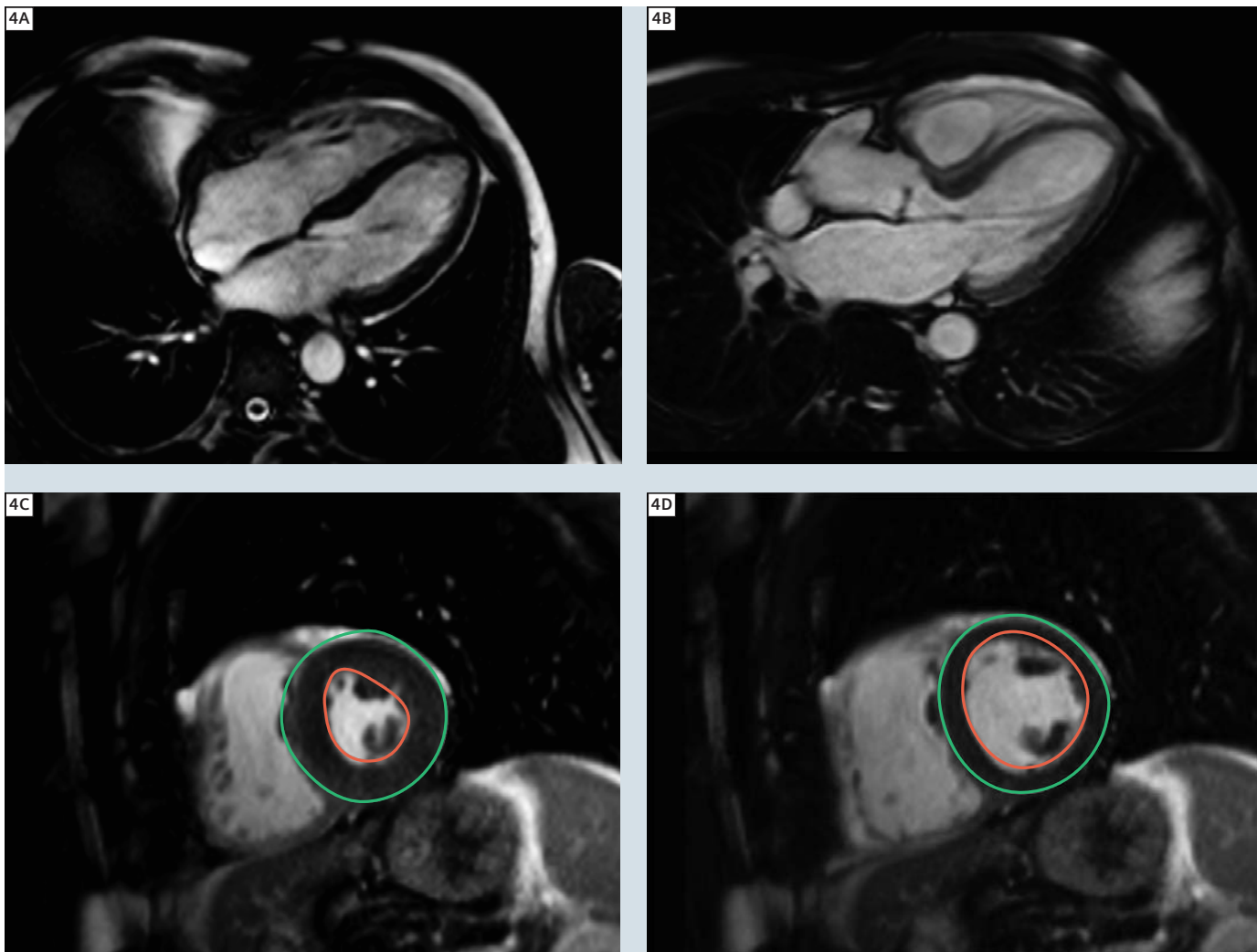
- Shift slices to the **Left Ventricle** as shown.
- This will cause patient table to move and position the **heart at the isocenter** of the scanner.

Exam Settings



After defining isocenter hit "Apply".
NOTE: Inform patient about the potential table movement.

3 Iso-center scanning. Support by guidance images and text the user can move the left ventricle to the iso-center to ensure high scan quality



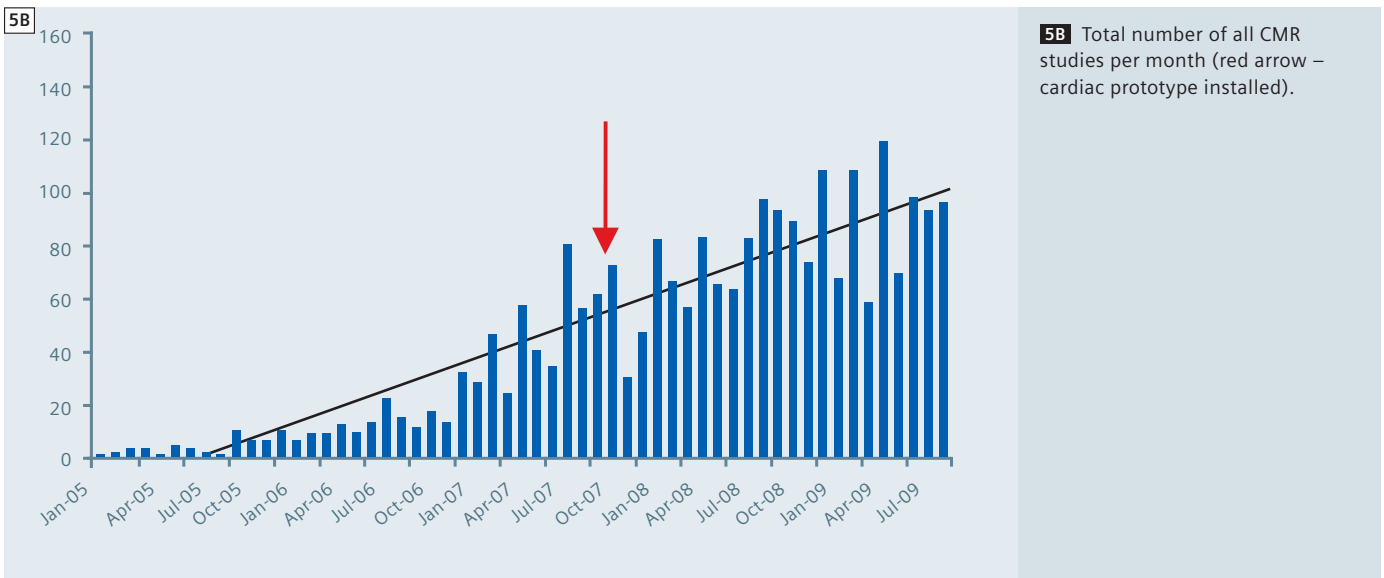
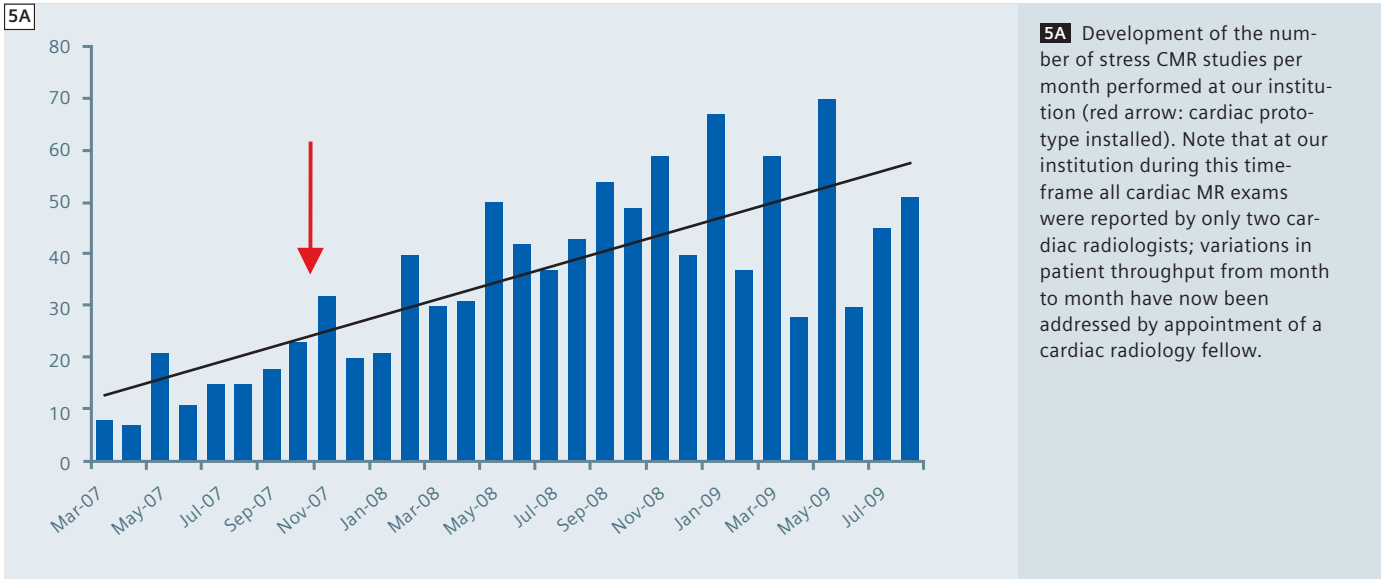
4 Exemplary cine-images from a typical CMR exam, performed after the introduction of the WIP software package, scanned by a less experienced technologist. A standard 4-chamber view is shown in **4A**. No manual adjustments were required, not even for dedicated planes like the LVOT (left ventricular outflow tract). Segmentation of the left ventricular wall on the short axis (**4C, D**) was calculated by the integrated Inline segmentation tool and required no interaction neither by the technologist nor the radiologist.

Clinical setting

The Royal Bournemouth is an acute-care general hospital (900 beds) with a large regional cardiac unit performing over 2500 procedures per year. The cardiac MRI (CMR) service started in 2004, initially providing basic structural informa-

tion only. CMR stress exams started in 2007. Our patient population is almost exclusively adult. CMR is used to provide structural and functional information and is used particularly for planning revascularisation strategies in patients with known coronary artery disease.

Extensive process-mapping was undertaken in order to identify areas in which the scanning process could be accelerated. Even with these changes, stress heart exams required a time-slot of 1 hour using conventional software. There were also major issues regarding



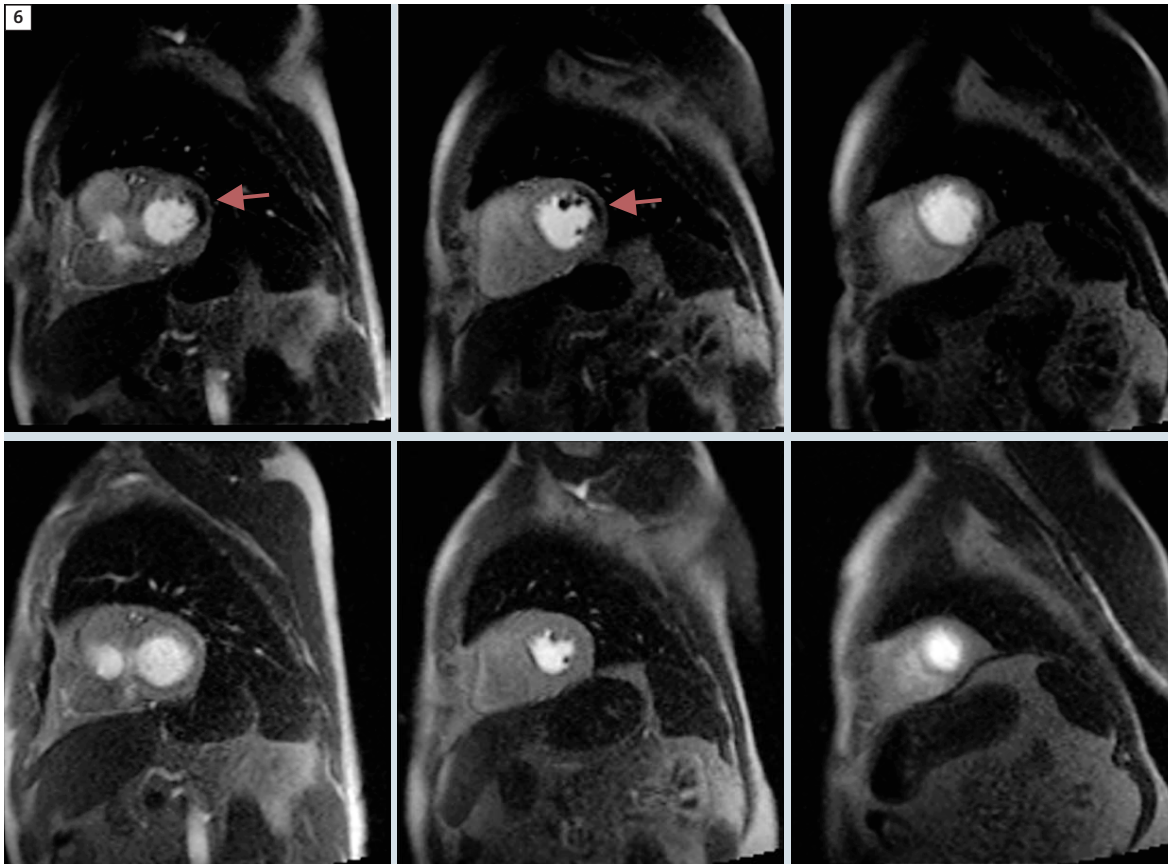
staff training due to the complexity of the procedures and the lack of familiarity with cardiac anatomy and cardiac planes.

Clinical experiences

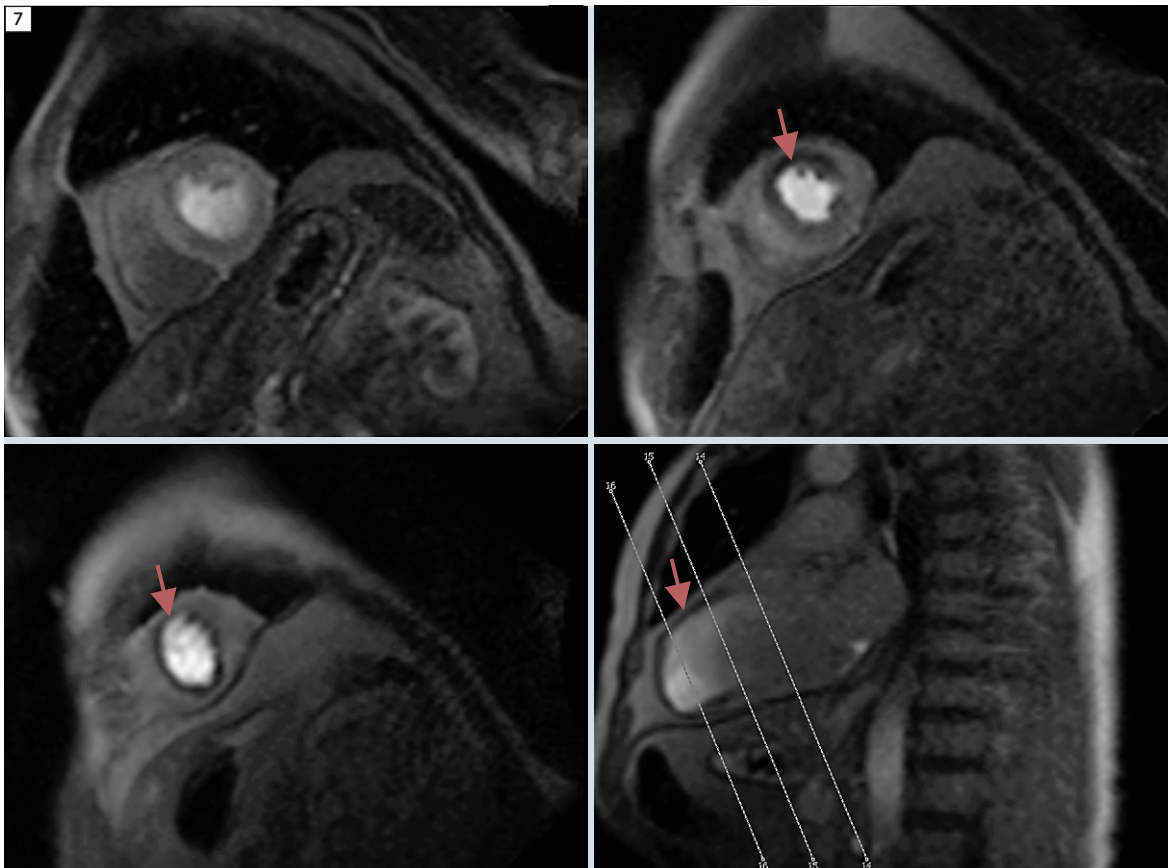
The cardiac WIP software has transformed the scanning process for cardiac

MRI patients. The most difficult MR examination has become much more straightforward and now, even relatively inexperienced staff members are able to scan cardiac patients quickly and efficiently. The increased scanning speed has raised throughput by 50%**, now

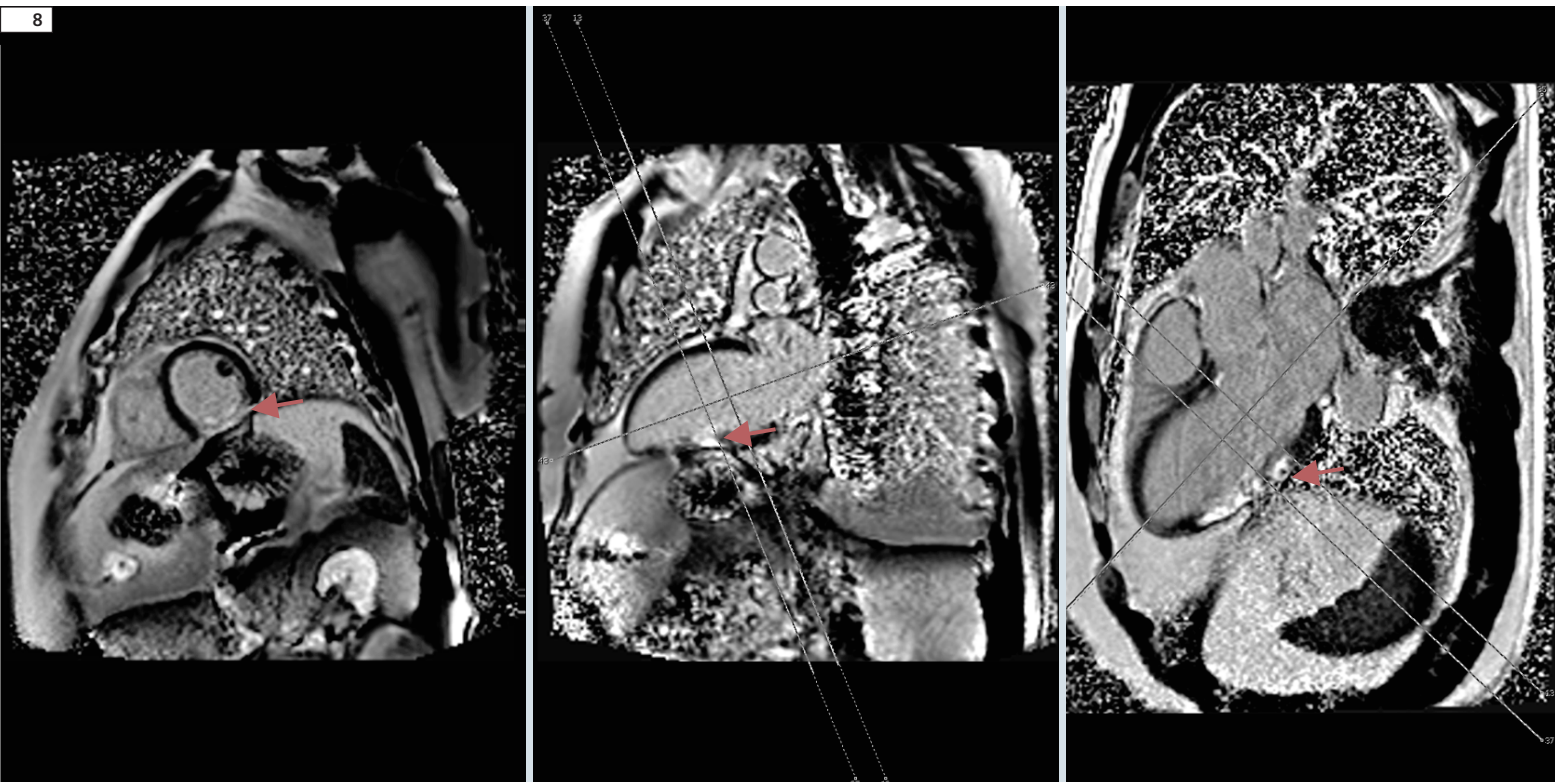
allowing 6 patients to be scanned in a 4 hour session rather than only 4 before. This software enables us to scan over 1000 cardiac patients per year in a general department, scanning up to 120 cases per month using only 10% of total scanning capacity. The prototype



6 Short axis stress CMR images using cardiac prototype showing lateral wall subendocardial defect (arrow) secondary to circumflex lesion (upper row). This resolved following successful stenting (lower row).



7 Stress CMR using cardiac prototype showing anterior wall/apical subendocardial defect (arrow) secondary to critical mid-LAD lesion. The prototype always acquires 3 short axis stress images and adaptively includes additional selected views if R-R interval allows (additional 2-chamber view shown in Fig. 8).



8 Short axis, 2-chamber and LVOT PSIR images showing old inferior infarct (arrow).



Dr. Russel Bull and Matthew Benbow (left).

has made training easier and scanning much simpler and faster thus enabling incorporation of cardiac examinations into the workload of a busy general hospital. All 16 scanning staff now perform cardiac examinations compared with just 3 before. The imaging results are now much more robust and quality is consistently high due to standardization. The increased speed has also made the scanning process more pleasant for patients, particularly for those suffering from claustrophobia.

*WIP – Work in progress. The information about this product is preliminary. The product is under development and not commercially available in the U.S., and its future availability cannot be ensured.

**Results may vary. Data on file.

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