Cardiac Imaging with MAGNETOM Prisma: Initial Experience

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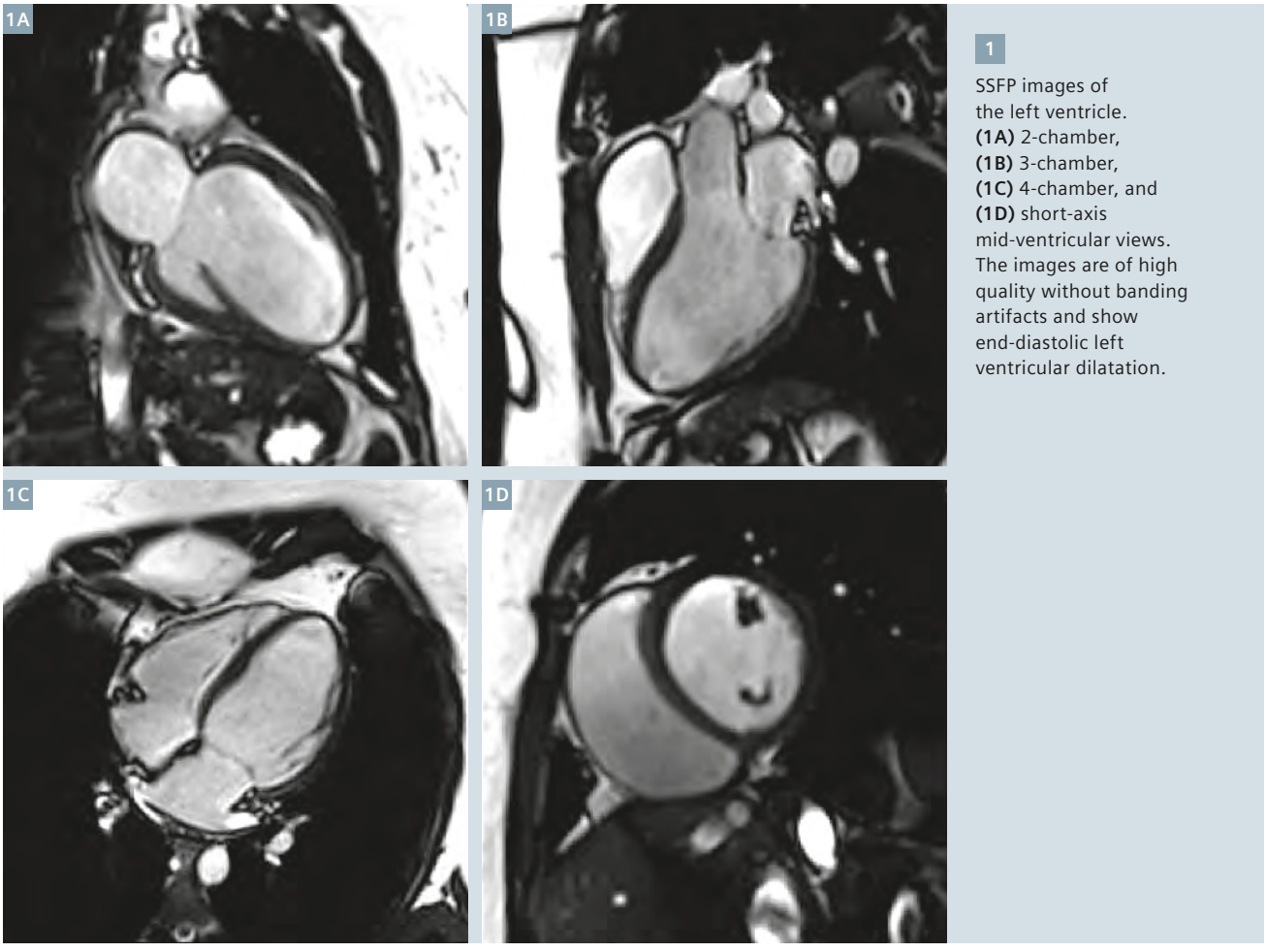
Introduction

Since its introduction at the RSNA 2012, the Siemens 3T MAGNETOM Prisma MRI scanner has been promising the highest quality of MR images.

Some of the features that make it unique to its competitors are its remarkable gradient performance with 80 mT/m @ 200 T/m/s gradients simultaneously on all three axes with fast switching capabilities, the 60 cm bore helping the high homogeneity of the magnetic field, the zero helium boil-off, the latest signal transmit and receive technologies by Siemens (TimTX TrueShape and Tim 4G) and the force-compensated design to reduce vibrations.

The above-mentioned features provide an unprecedented image quality with significantly higher resolution and fewer artifacts. Moreover, the new Tim 4G coil technology with 48, 64 or 128 independent channels provides faster imaging with higher signal-to-noise ratio (SNR). Another great feature that makes this scanner unique is its powerful shimming system with an excellent magnet homogeneity that could be achieved with its advanced higher order shim and/or optional SpectroShim [1].

With all these unparalleled promises, it should not be a surprise that MAGNETOM Prisma has succeeded to draw the attention of CMR specialists as a potential next big step in the field



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SSFP images of the left ventricle. **(1A)** 2-chamber, **(1B)** 3-chamber, **(1C)** 4-chamber, and **(1D)** short-axis mid-ventricular views. The images are of high quality without banding artifacts and show end-diastolic left ventricular dilatation.

of cardiac MRI. This article is intended to provide a brief report on our initial experience with this system, to illustrate examples of some of the cases we examined and to highlight the unique differences compared to other MRI scanners.

Our initial experience

Case 1

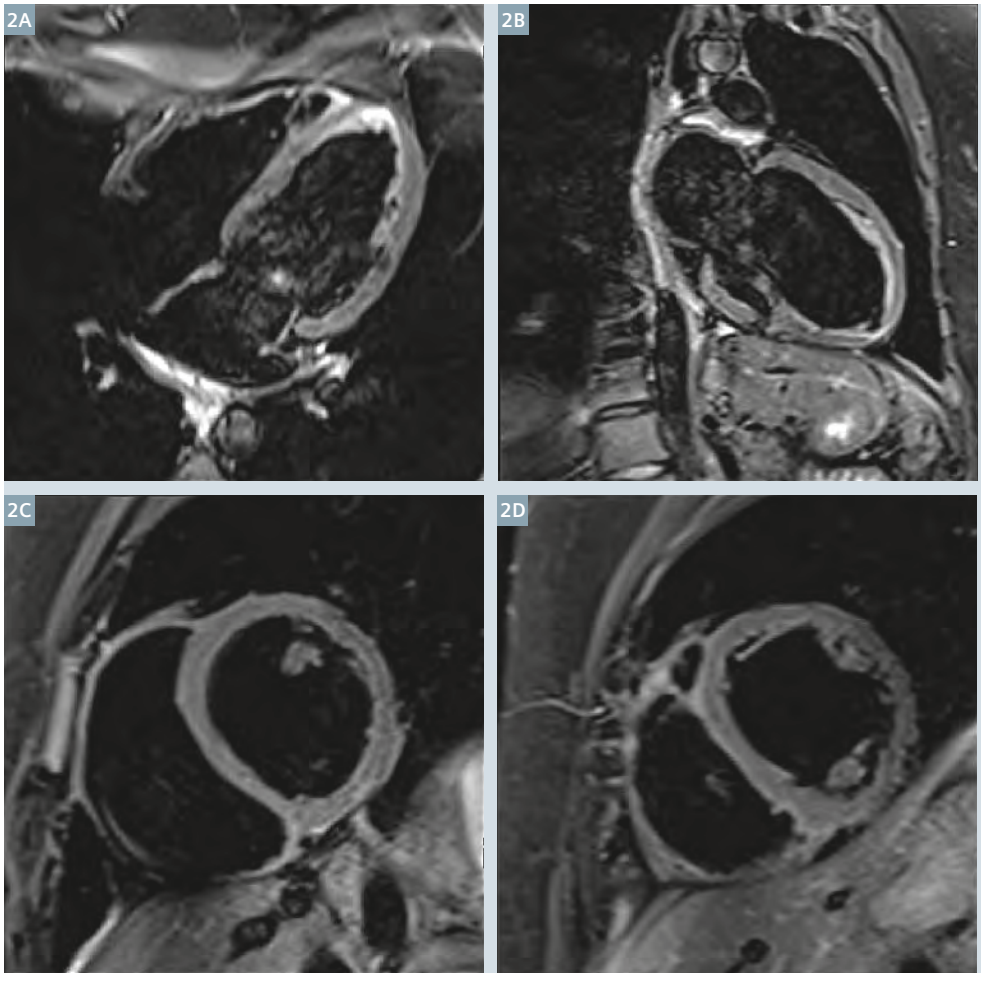
A 31-year-old female patient presented with a history of unclear chest pain for the last 2 to 3 months and ankle edema. Her family history was strongly positive for dilated cardiomyopathy. Echocardiography was suspicious for an early dilatation of the left ventricle and showed mildly reduced left ventricular function. Further evaluation with cardiac MRI was advised.

Her examination protocol was adapted to the 2013 updated standardized cardiovascular magnetic resonance (CMR) protocols published by the Society for Cardiovascular Magnetic Resonance (SCMR) [2]. This included the left ventricular structure and function module (SSFP cine images in long and short axes), myocardial edema module (TIRM), first pass perfusion at rest and late gadolinium-enhancement modules.

The SSFP cine images were visually suggestive of a left ventricular dilatation (Fig. 1). The left ventricular function was reduced with global hypokinesia, especially in the septum and inferoseptal. The End-Diastolic-Volume (EDV) was 189 ml (normal range in females 88–168 ml); whereas the indexed EDV (EDVi) was 93 ml/m^2 (normal range in females 57–92 ml/m^2). There was no late enhancement or myocardial edema, (Fig. 2). The findings were suggestive of an early dilated cardiomyopathy without fibrosis or scarring.

What is of importance in this example is that we did not have to perform any frequency scouts, which is the norm in other 3T MRI systems. The SSFP cine images were of excellent quality without any banding artifacts.

As it is known, the banding artifacts appear at frequencies that show a positive to negative phase transition of the signal and depend on susceptibility differences that cause variations in the main magnetic field. These differences are more prominent on higher magnetic fields; hence banding artifacts are more prevalent at 3T [3]. To get rid of these, it is customary to perform a frequency scout prior to SSFP sequences and select the most appropriate frequency with the least artifacts, rendering imaging at 3T more time consuming and sometimes difficult compared to 1.5T. In our experience, Prisma has shown excellent results without the need to perform frequency scouts in the vast majority of cases.



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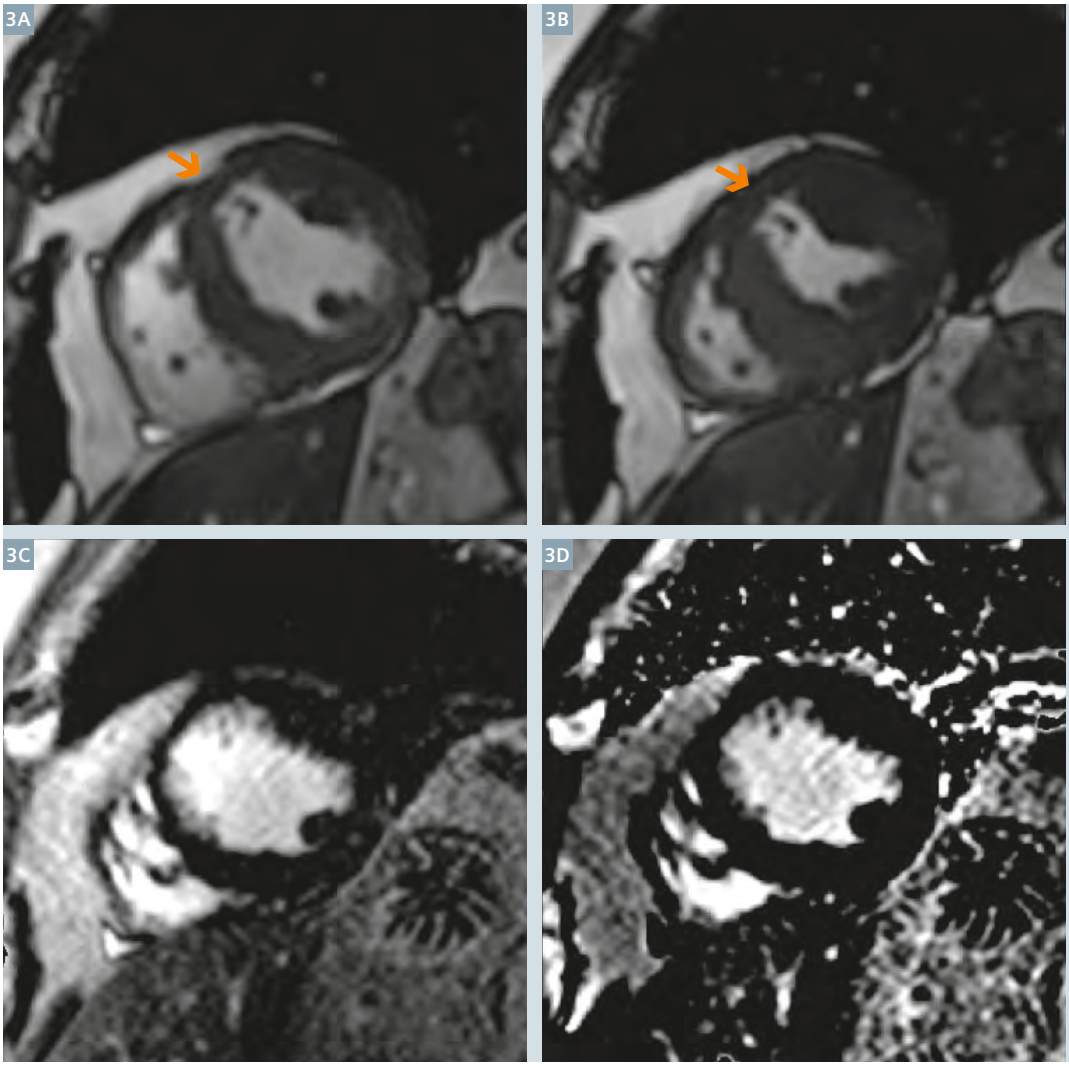
TIRM images (sensitive to myocardial edema) showing high quality and resolution. There is no evidence of myocardial edema.



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SSFP SAX showing thinning of the myocardium anteroseptal ((**3A**) ED, (**3B**) ES), with subendocardial late-enhancement in the corresponding region ((**3C**) magnitude image and (**3D**) PSIR image).

Case 2

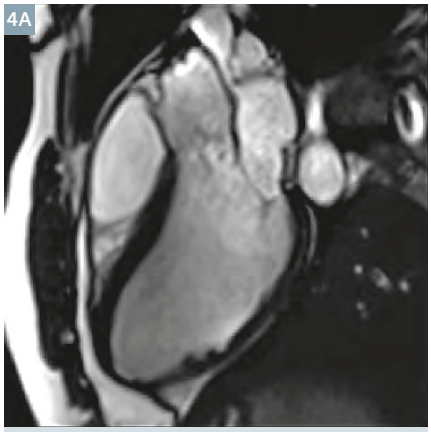
A 57-year-old male patient with known triple coronary artery disease presented with progressive chest pain and dyspnoea on exertion. Echocardiography showed minimal reduction in left ventricular function with a left ventricular EF of 52% and anteroapical akinesia. Coronary angiography showed a 60% stenosis in left main, a subtotal proximal LAD obstruction, a 50% stenosis of the circumflex artery and a chronic obstruction of the RCA showing collateral blood supply. The question of myocardial viability was raised to justify a re-vascularisation procedure. The patient was sent for a CMR examination.

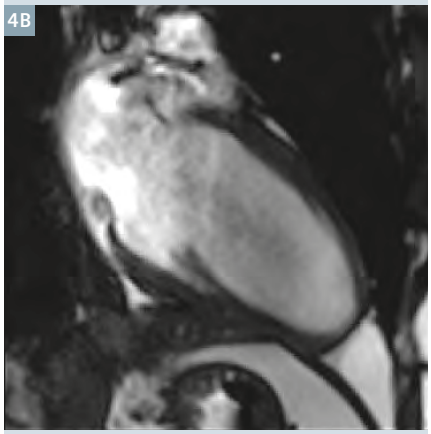
His examination protocol included the left ventricular structure and function module (SSFP cine images in long and short axes), myocardial edema module (TIRM) and late gadolinium-enhancement module.

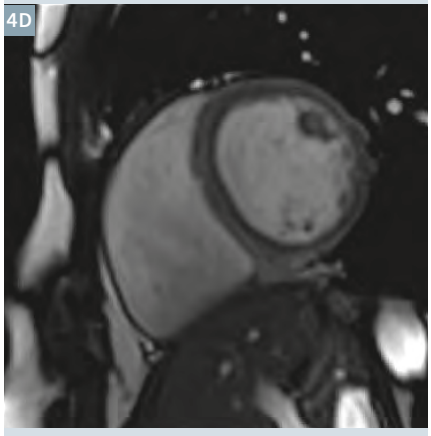
SSFP images showed anteroseptal myocardial thinning with regional akinesia, in addition to inferoseptal and lateral wall hypokinesia in the basal region. Late-enhancement images showed scar formation in the anteroseptal region with potentially viable adjacent myocardium (Fig. 3).

The patient underwent a bypass operation (LIMA to LAD and a sequential vein bypass graft to ramus intermedius and circumflex) and showed a significant improvement postoperatively.

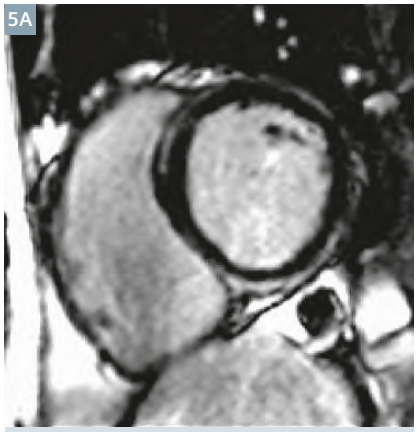
This example again helps to enforce the fact that we were able to obtain excellent SSFP images without the drawbacks of a 3T system. Moreover, late-enhancement images were of excellent quality.

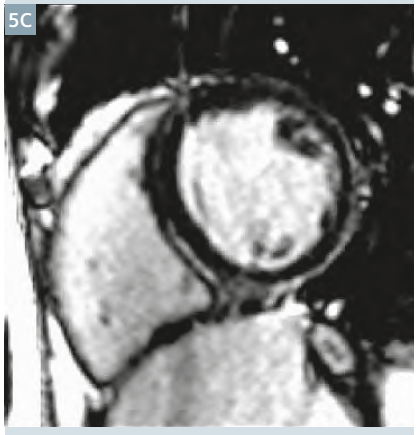






4 SSFP cine images showing mild dilatation of the left ventricle.





5 Late-enhancement images showing subepicardial and mid-myocardial late gadolinum-enhancement.

Case 3

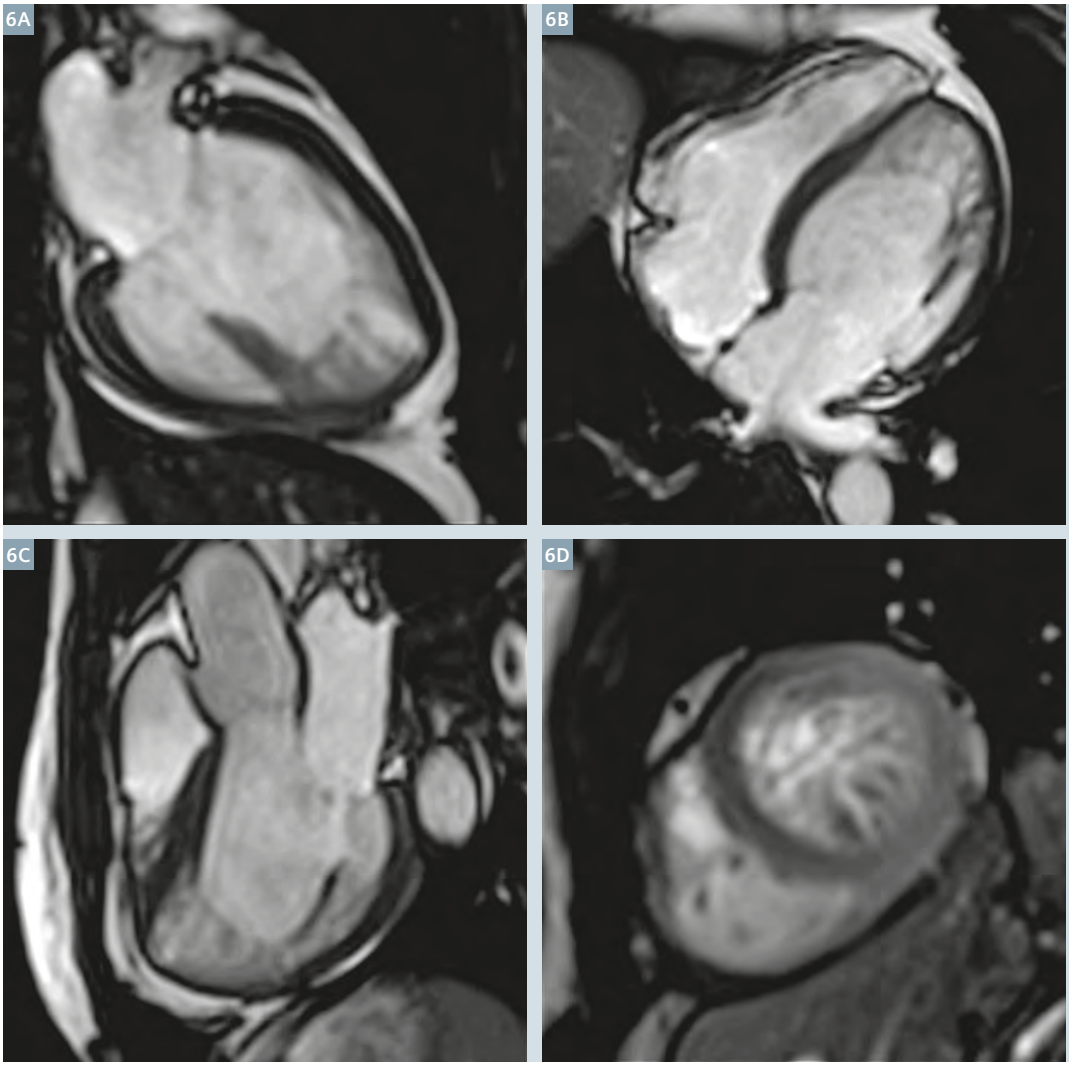
A 34-year-old male patient presented to the cardiologist with history of extrasystoles and tachycardia for the last 4 months. Echocardiography showed mild reduction in LV function (LVEF 50%) without any regional wall motion abnormalities. The patient was referred to cardiac MRI with suspected myocarditis.

His examination protocol included the left ventricular structure and function module (SSFP cine images in long and short axes), myocardial edema module (TIRM) and late gadolinium-enhancement module.

SSFP images showed dilatation of the left ventricle with EDV of 198 ml and EDVi of 177 ml/m^2 (Fig. 4). There was also a left ventricular function reduction comparable to the echocardiography findings (49%).

The late enhancement findings were of remarkable quality showing patchy and mid-myocardial late-enhancement in the septum, in addition to a subepicardial late-enhancement specially in the lateral, inferoseptal and anterior wall, which is the most common pattern seen in cases of myocarditis [4].

Taking all findings into consideration, a diagnosis of an early dilated cardiomyopathy post myocarditis was made.



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SSFP images showing non-compacted myocardium in the apical region.

Case 4

A 41-year-old female patient presented to the emergency department with sudden onset of weakness. She had abnormal EKG and cardiologists were consulted. Echocardiography showed suspected non-compaction of the myocardium. She was referred for a cardiac MRI.

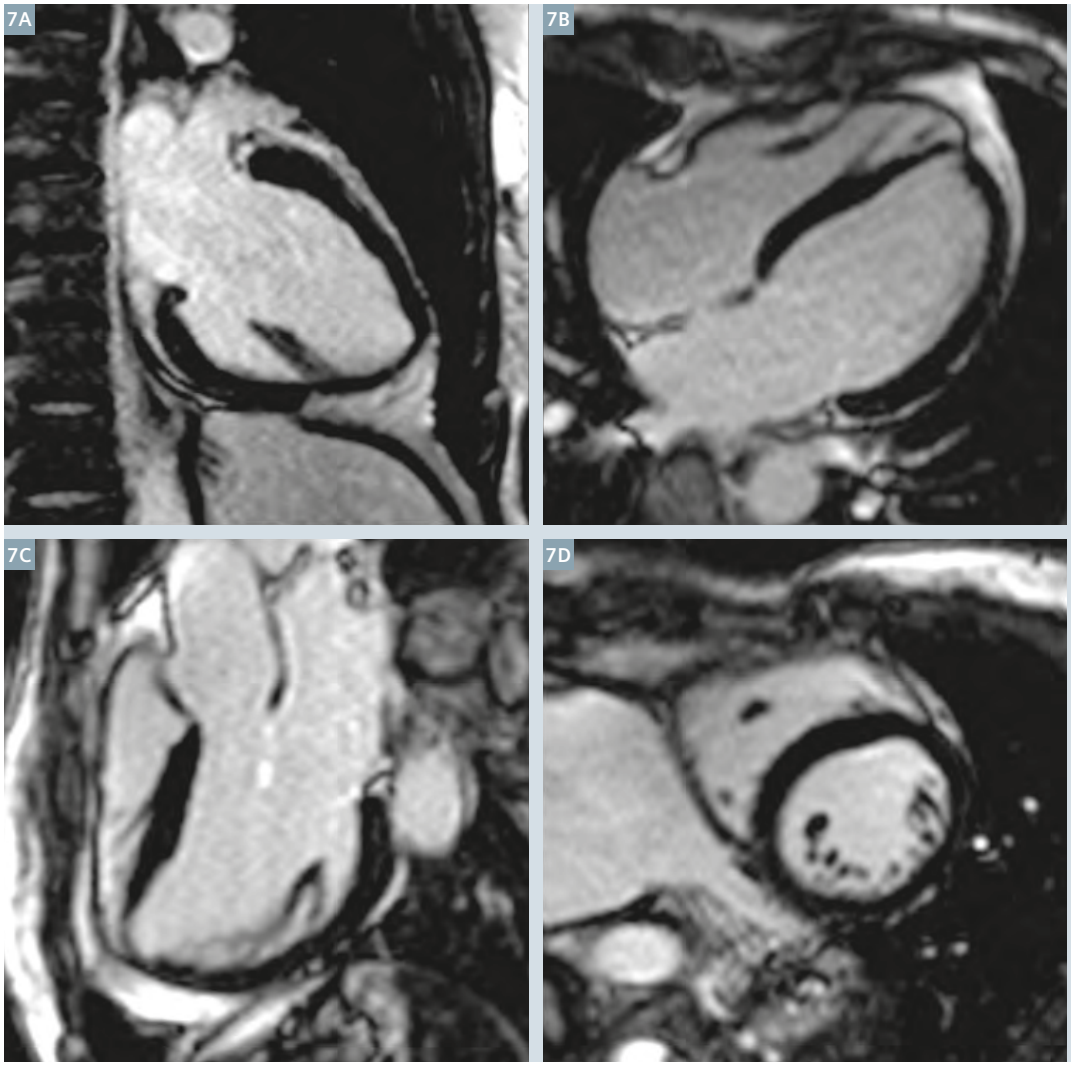
The examination protocol comprised the left ventricular structure and function module (SSFP cine images in long and short axes), myocardial edema module (TIRM) and late gadolinium-enhancement module.

SSFP images showed non-compacted myocardium in the apical region with hypokinesia (Fig. 6). No late-enhancement was present (Fig. 7). The ratio of non-compacted to compacted myocardium was > 2.3, which has been shown to be 86% sensitive and 99% specific for the diagnosis of non-compaction cardiomyopathy [5]. Hence a diagnosis of a non-compaction cardiomyopathy was made.

Conclusion

With its high quality images, fast acquisition time and the ability to acquire cine images without the need for an external ECG monitor or for a frequency scout in most of the cases, MAGNETOM Prisma MRI system seems to be a remarkable evolution for cardiac imaging.

References
1 www.siemens.com/prisma
2 Kramer, C. M., Barkhausen, J., Flamm, S. D., Kim, R. J., & Nagel, E. (2013). Standardized cardiovascular magnetic resonance (CMR) protocols 2013 update. Journal of Cardiovascular Magnetic Resonance, 15(1), 91. doi:10.1186/1532-429X-15-91.
3 Oshinski, J. N., Delfino, J. G., Sharma, P., Gharib, A. M., & Pettigrew, R. I. (2010). Cardiovascular magnetic resonance at 3.0T: Current state of the art. Journal of Cardiovascular Magnetic Resonance, 12(1), 55. doi:10.1186/1532-429X-12-55.
4 Cummings, K. W., Bhalla, S., Javidan-Nejad, C., Bierhals, A. J., Gutierrez, F. R., & Woodard, P. K. (2009). A Pattern-based Approach to Assessment of Delayed Enhancement in Nonischemic Cardiomyopathy at MR Imaging1. Radiographics, 29(1), 89–103. doi:10.1148/rg.291085052.



7 Late-enhancement images showing no scars.

5 Petersen, S. E., Selvanayagam, J. B., Wiesmann, F., Robson, M. D., Francis, J. M., Anderson, R. H., et al. (2005). Left ventricular non-compaction: insights from cardiovascular magnetic resonance imaging. Journal of the American College of Cardiology, 46(1), 101–105. doi:10.1016/j.jacc.2005.03.045.

MAGNETOM Prisma is not commercially available in all countries. Due to regulatory reasons their future availability cannot be guaranteed.

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