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Cardiovascular MRI

Answers for life.

How can I make cardiovascular MRI imaging part of my routine?

How can I perform a comprehensive MRI stress test including function, perfusion, and viability in under 30 minutes?

How can I achieve consistent image quality in cardiac MRI and MR angiography?

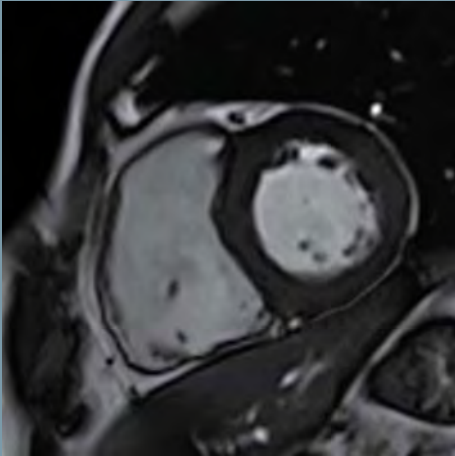
Cardiovascular MRI

Cardiac MRI is widely regarded as a highly complex examination, but also as one of the most comprehensive diagnostic tools in cardiology. With easier tools and better technology available, cardiac MRI is spreading more into routine use. The Cardiac Dot Engine is at the center of this development, as it makes examinations faster and more robust. At the same time, it offers new processing capabilities, helping make diagnoses of perfusion images easier and more standardized.

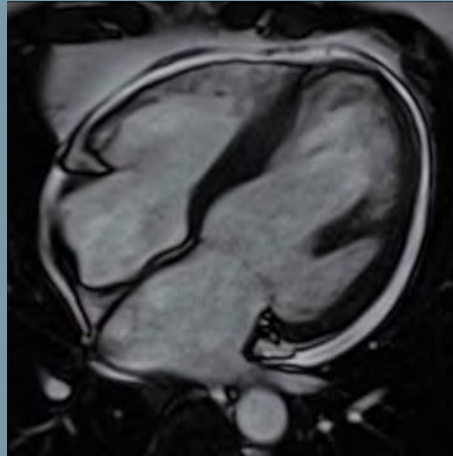
Cardiac MRI offers excellent soft tissue differentiation, high spatial and temporal resolution, and 3D as well as 4D data acquisition. These and other sophisticated capabilities make cardiovascular MRI ideally suited for an array of studies, such as evaluation of cardiac anatomy and morphology, ventricular and valvular function, myocardial perfusion and viability, flow, and angiography. Furthermore, cardiac MRI is a useful tool for monitoring myocardial tissue to differentiate between reversible and irreversible as well as acute from healed myocarditis. MRI assessment of myocardial iron and function has modified the treatment of thalassemia.

MR angiography (MRA) is performed at almost every MRI system, but very often the quality of the results varies depending on the user and the patient.

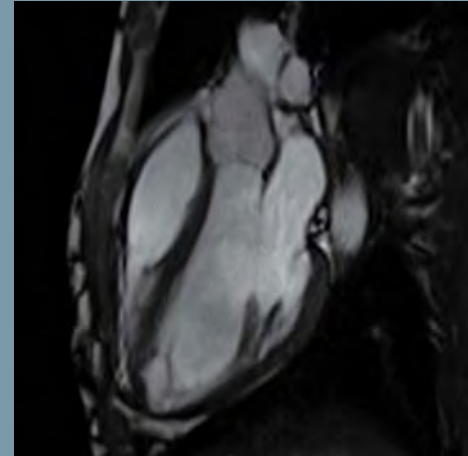
With the broad spectrum of contrast and non-contrast applications such as the TimCT Angio Dot Engine, the Angio Dot Engine, *syngo* TWIST, and *syngo* NATIVE, Siemens provides excellent tools to achieve consistently excellent results.



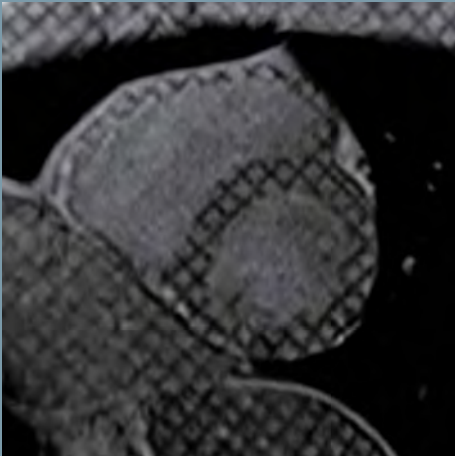
Cardiac Function, TrueFISP cine retro, GRAPPA 2;
MAGNETOM Verio
EKO MRI Centre, Kolkata, India



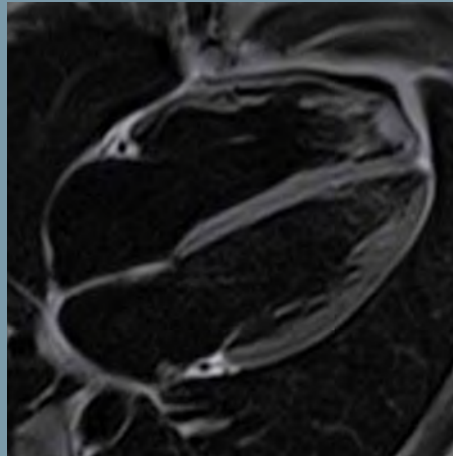
Cardiac Function, TrueFISP cine retro, GRAPPA 2;
MAGNETOM ESSENZA
Medical Center Pro Vita, Sofia, Bulgaria



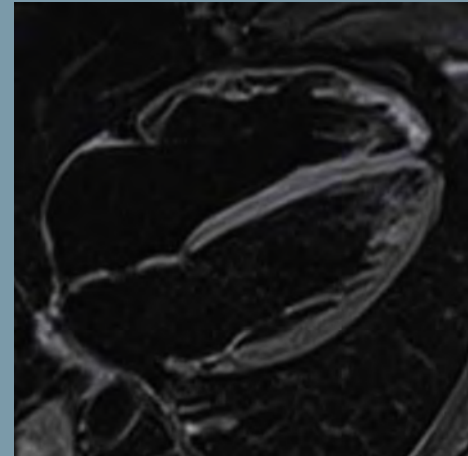
Cardiac Function, TrueFISP cine retro,
GRAPPA 3; MAGNETOM Skyra



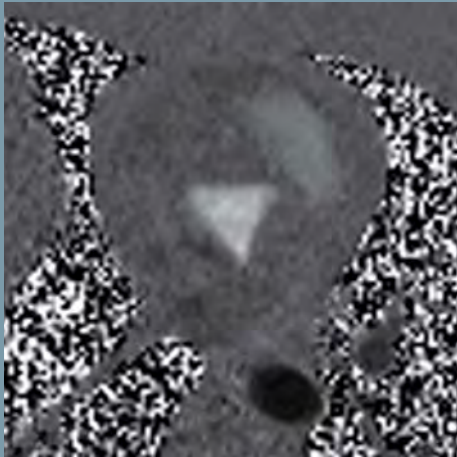
Cardiac Function, FLASH cine tagging;
MAGNETOM Espree



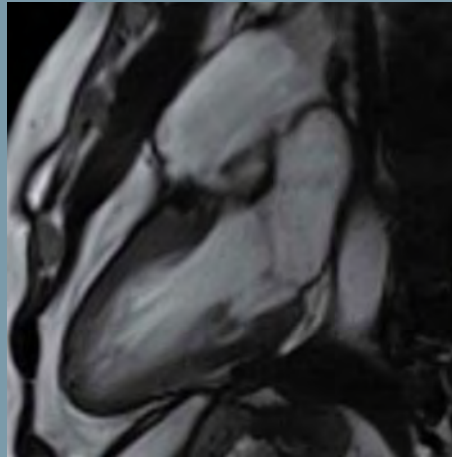
Cardiac Morphology, T2 TSE Dark Blood, GRAPPA
2; MAGNETOM Aera



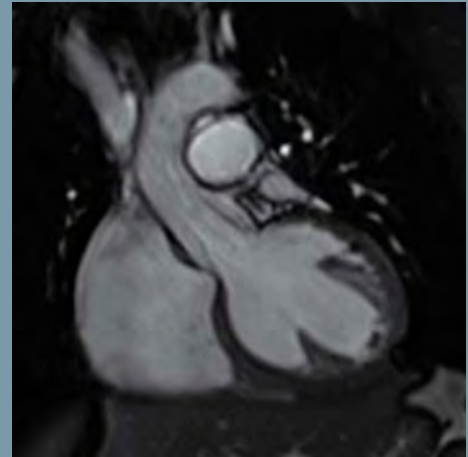
Cardiac Morphology, T2 TSE SPAIR Dark
Blood, GRAPPA 2; MAGNETOM Aera



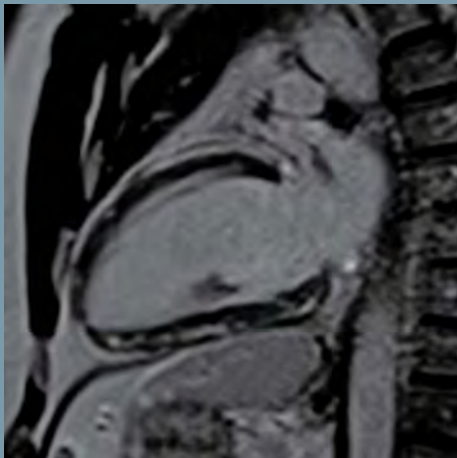
Cardiac flow FLASH cine retro phased;
MAGNETOM Avanto



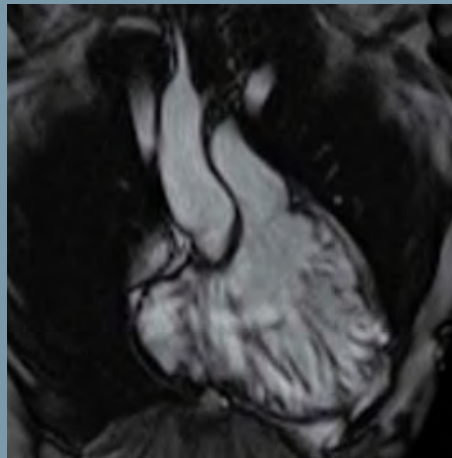
Cardiac Function, TrueFISP cine radial,
32-channel Body coil; MAGNETOM Verio



Cardiac Function, TrueFISP cine retro,
GRAPPA 2; MAGNETOM Skyra
AKH, Linz, Austria



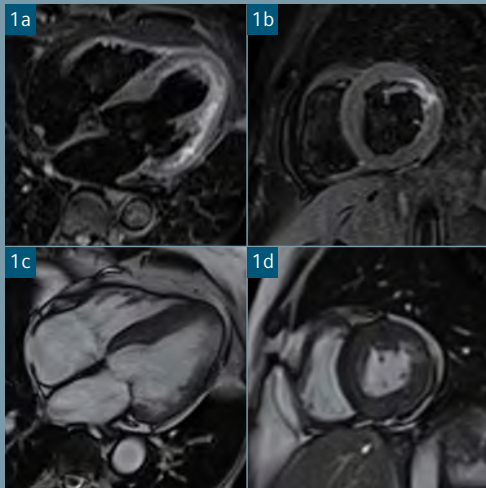
Cardiac Viability, FLASH IR post contrast,
GRAPPA 2; MAGNETOM Aera
Centre Cardio Thoracique de Monaco,
Monaco



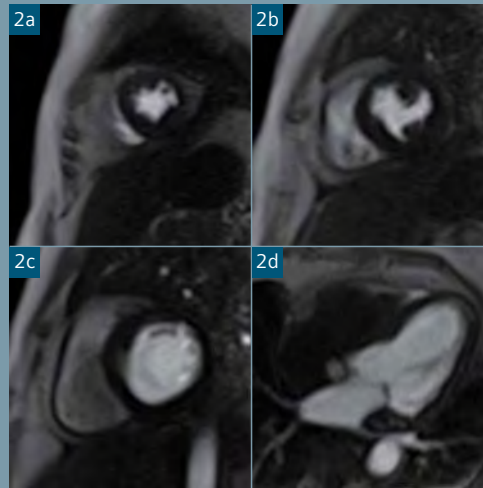
Cardiac Function, TrueFISP cine retro, GRAPPA 2;
MAGNETOM Avanto
BC Children's Hospital, British Columbia, Canada



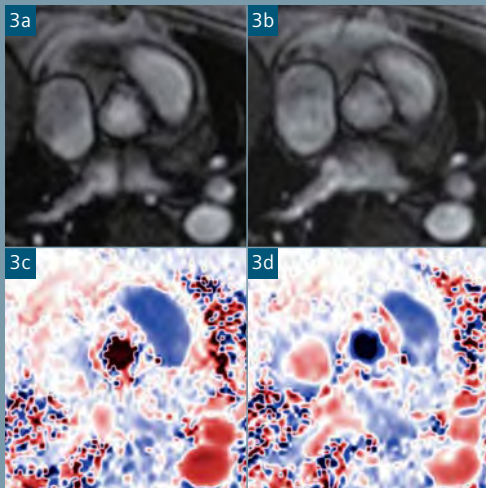
Cardiac Non-contrast Coronary Angiography,
T2 3D TrueFISP, thin MIP; MAGNETOM Aera



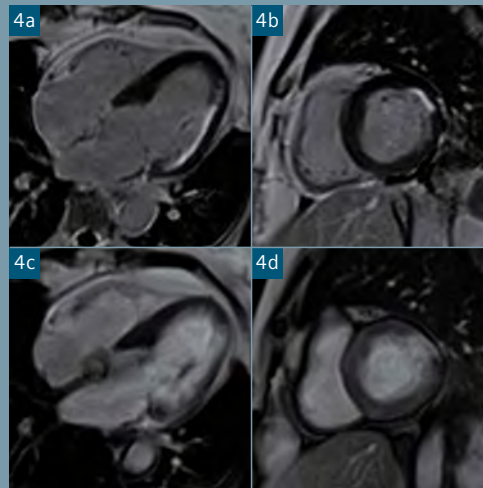
1a and 1b: Cardiac Morphology, TIRM Dark Blood
 1c and 1d: Cardiac Function, TrueFISP cine retro, GRAPPA 2



2a – 2d: Cardiac Perfusion, Turbo FLASH post contrast, GRAPPA 2



3a and 3b: Cardiac Flow, FLASH cine retro, GRAPPA 2
 3c and 3d: Cardiac Flow, FLASH cine retro, GRAPPA 2, phased



4a and 4b: Cardiac Viability, IR Flash post contrast, GRAPPA 2
 4c and 4d: Cardiac Viability, IR TrueFISP FatSat post contrast, GRAPPA 2

Clinical case from one patient: acute myocardial infarction,
 MAGNETOM Aera
 Centre Cardio Thoracique de Monaco, Monaco

Cardiac Dot Engine



To bring cardiac MRI to the routine, the Cardiac Dot Engine guides users through the examination step-by-step to help achieve excellent results, consistently. In addition, patient-specific adaptation to the individual condition and workflow automation helps the user achieve fast and consistent results.

Personalized:
parameter adaption to heart rate and breath hold capability

Guided:
guidance through placing five anatomical landmarks for automated slice positioning

Automated:
slice positioning is matched for the entire exam and standard cardiac views are obtained automatically

The screenshot displays the Cardiac Dot Engine software interface. At the top, there is a menu bar with options: Patient, Applications, Transfer, Edit, Queue, Protocol, View, Image, Tools, Evaluation, Scroll, System, Options, Help. The main area is divided into several sections:

- Top Left:** Two MRI scan images labeled LBP and AFR, showing cross-sections of the heart with yellow dashed lines indicating anatomical landmarks.
- Top Right:** A table titled "LVE Ventricular Function" with columns for "Absolute" and "Normalized".
- Bottom Left:** An ECG waveform and a list of scan parameters.
- Bottom Center:** A "Guidance" window with a "Parameter" tab. It displays a "NOTICE: Please position slice on short-axis and 4-chamber view as shown." and three small MRI images labeled "short-axis", "4-chamber", and "2-chamber RV".
- Right Side:** A vertical sidebar with buttons for "Exam", "Acquiring", "Planning", and "3D".

	Absolute	Normalized
Ejection Fraction	EF	67 %
End Diastolic Volume	EDV	123 ml
End Systolic Volume	ESV	40 ml
Stroke Volume	SV	83 ml
Cardiac Output	CO	6.4 l/min
Cardiac Index	CI	3.4 l/min/m ²
Average Heart Rate	HR	80 bpm
Normalized to patient surface area		1.8 m ²
Patient Height		1.68 m
Patient Weight		55 kg

Check ED & ES. Computer estimated ED & ES settings may not be accurate.
Check contours. Computer generated contours may not correspond to anatomy.

TA: 9.3 s PM REF PAT Off Voxel size: 2.4x2.3x5.0 mm Ref. SNR: 1.00

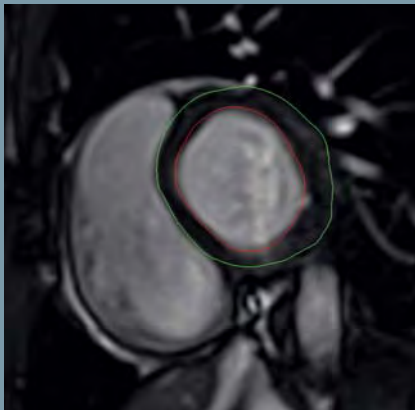
Close Guidance to switch to Parameter Card or more



One of today's most important clinical needs is being able to perform a comprehensive ischemic heart evaluation within 30 minutes. This includes function, perfusion, and viability analysis – a comprehensive examination that only MRI can offer as a single modality. The Cardiac Dot Engine supports complete exams for ischemic and non-ischemic diseases. Inline technology speeds up the workflow even more with Inline VF (Ventricular Function) and Inline Time Course Evaluation (Inline Perfusion).

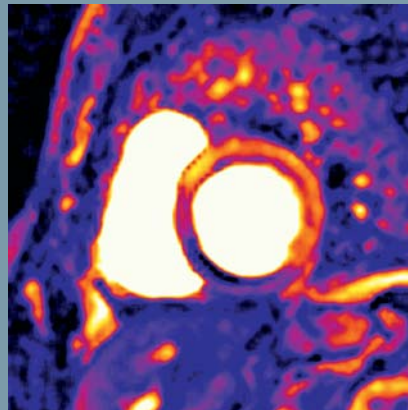
Inline Function

Cardiac Function, TrueFISP cine retro, GRAPPA 3, Argus; MAGNETOM Aera
Northwestern Memorial Hospital, Chicago, USA



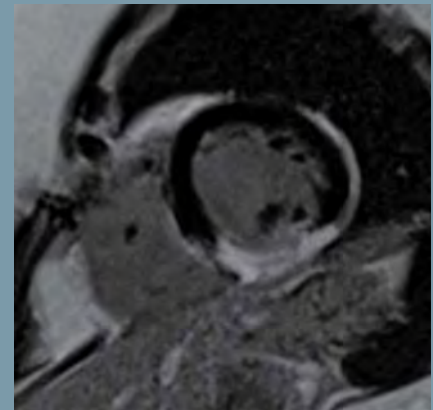
Inline Perfusion

Cardiac Perfusion, Turbo FLASH post contrast, Upslope Map, GRAPPA 2; MAGNETOM Aera
Northwestern Memorial Hospital, Chicago, USA



Viability

Cardiac Viability, FLASH IR post contrast; MAGNETOM Avanto
Helios Klinikum Berlin-Buch, Berlin, Germany

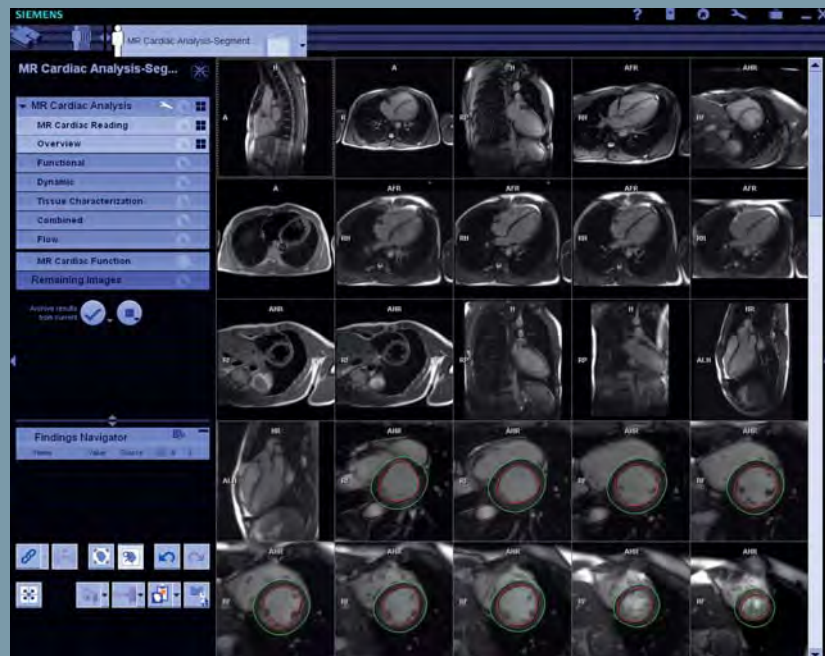


syngo.via*

Working with large amounts of cardiac MRI data like morphology, cine, perfusion or viability on a conventional workstation can be a challenge. Multiple applications are needed; synchronization and navigation capabilities may be insufficient. *syngo.MR General Engine* offers a rich suite of functionality to cover all routine reading and post processing needs. Be it managing images from different cardiac views or phases; or searching for useful information from

other acquisitions, the *syngo.MR Cardiac Reading* workflow in our *syngo.MR General Engine* already links all the data and images to the relevant series.

Features include guided workflows, synchronization of data through space and time and at the end of the analysis, a dedicated structured Cardiac Report is generated.



* *syngo.via* can be used as a standalone device or together with a variety of *syngo.via*-based software options, which are medical devices in their own rights. *syngo.via* and the *syngo.via* based software options are pending in some countries the necessary clearances and thus are not available for sales in all countries.

** *syngo.MR Cardiac Flow* is not commercially available. Due to regulatory reasons its future availability cannot be guaranteed.

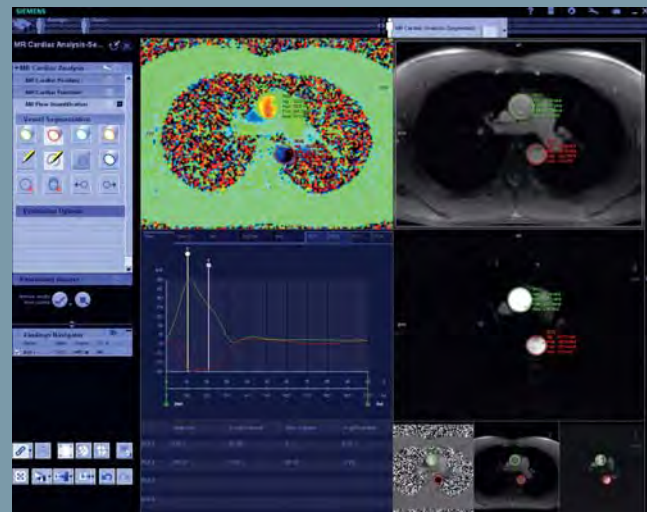
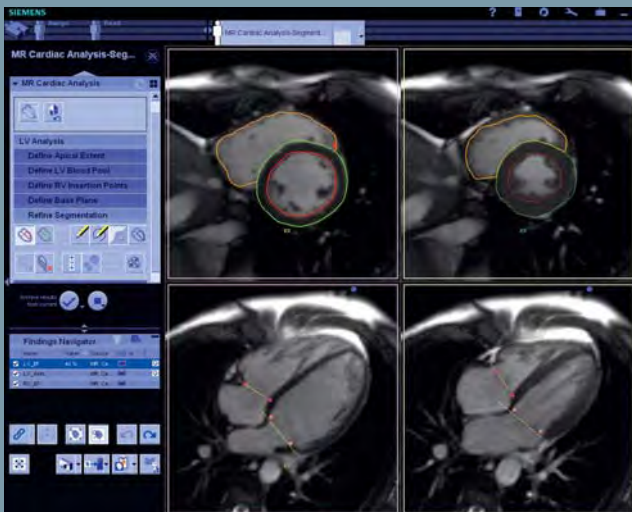
syngo.MR Cardiac 4D Ventricular Function

Functional and volumetric evaluation is the cornerstone of every cardiac MR examination in ischemic as well as non ischemic cardiomyopathies. *syngo.MR Cardiac 4D Ventricular Function* offers precise analysis of all relevant volumetric parameters such as ejection fraction, stroke volume, and segmental analysis of wall thickening.

syngo.MR Cardiac Flow**

With *syngo.MR Cardiac Flow*, the evaluation of blood flow dynamics is quick and easy. The flow analysis determines the mean and maximum velocity of blood flow.

Special Features include Velocity encoding gradient (venc) correction and one-click vessel segmentation.



MR Angiography

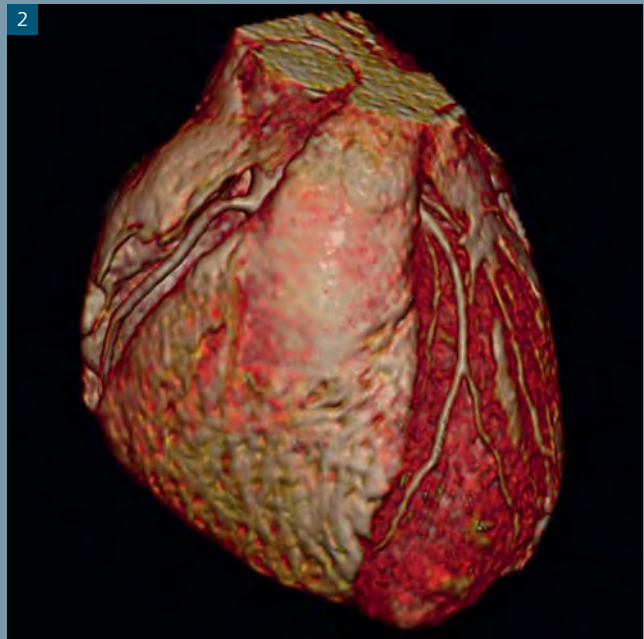
MR angiography is one of the most performed exams in MRI. In addition to diseases of the heart's vessels, MRA also helps diagnose large vessels disease, such as aortic dissection or pulmonary embolism. Furthermore, cerebrovascular diseases or peripheral artery diseases are often manifest in CAD patients. MRI offers not only visualization of vessel lumen like conventional angiography does, but also analysis of the vessel wall.

MR angiography is increasingly playing an important role for planning and guidance of vascular interventions offering high diagnostic accuracy, such as the 3D whole-heart coronary MRA, which enables a CT-like exam. The vascular information acquired through an MRI scan is used to plan or guide vascular intervention, which comprises

balloon angioplasty and other endovascular therapies like implantation of stent grafts and EP ablation planning.

MRI delivers fast and accurate angiography results, offering several advantages; visualization and quantification of flow, dynamic information through *syngo* TWIST and non-contrast angiography using *syngo* NATIVE.

Due to today's possibilities of scanning during continuous table movement (*syngo* TimCT), a complete angiographic study is now done in a matter of minutes. Vascular interventions under MRI guidance is a relatively new and emerging field, which holds great promise.

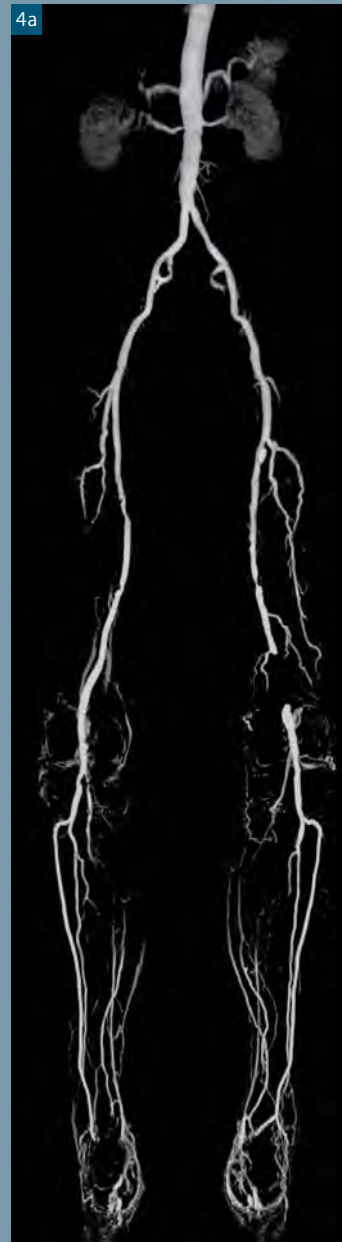


1: Carotid Angiography, 3D FLASH ce-MRA, VRT,
GRAPPA 3; MAGNETOM Verio
MR Bremen Mitte, Bremen, Germany

2: Coronary Whole Heart Angiography, T2 3D TrueFISP
FatSat VRT, GRAPPA 2; MAGNETOM Avanto
University Hospital UCLA, Los Angeles, USA

3: Non-contrast Pulmonary MRA, T2 SPACE IR, thin mIP,
inverted, GRAPPA 3; MAGNETOM Aera

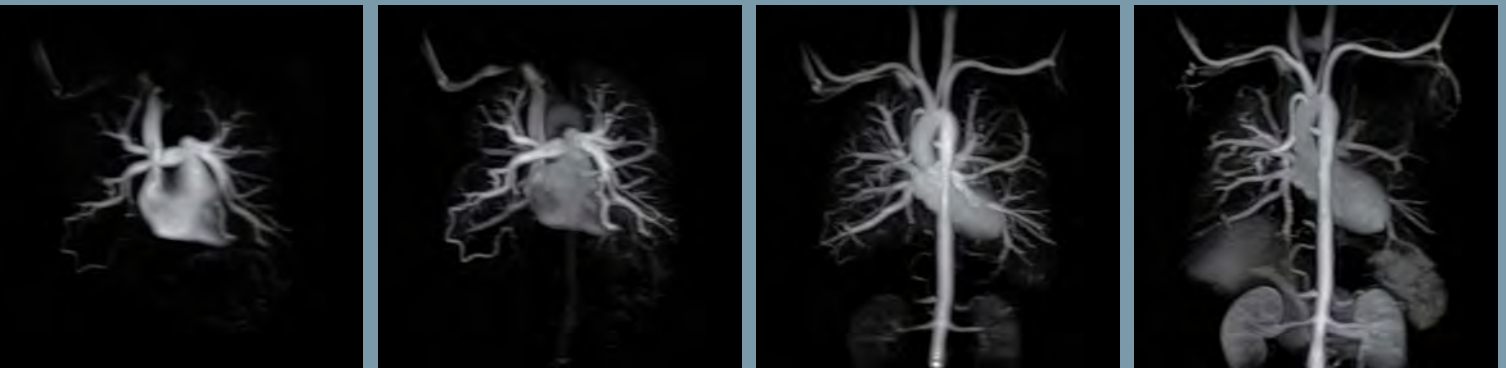
4a and 4b: Peripheral Angiography, 3D FLASH ce-MRA,
3 steps, MIP and MIP inverted, GRAPPA 2;
MAGNETOM Espree
Battlefield Imaging, Ringgold, USA



syngo TWIST

For a better detection of various congenital diseases *syngo* TWIST provides dynamic information. *syngo* TWIST is a time-resolved 3D MRA technique that achieves both a high temporal and spatial resolution. *syngo* TWIST offers a practical, flexible, and elegant way to perform sub-second, time-sequential 3D measurements. *syngo* TWIST provides further clinical information, including the evaluation of abnormal anatomy as well as vascular hemodynamics.

Throacic Angiography, 3D FLASH ce-MRA TWIST,
MIP dynamic, GRAPPA 3; MAGNETOM Aera
University Hospital of Saarland, Homburg, Germany



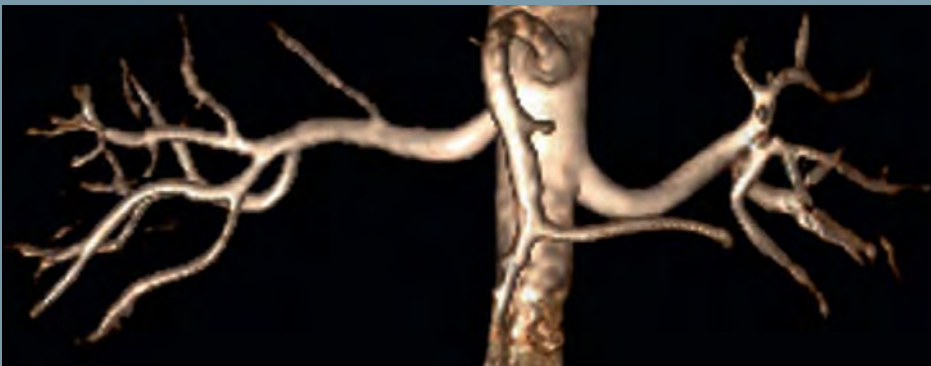
syngo NATIVE

syngo NATIVE is a contrast-free MR angiography technique for visualizing the vessels. The package contains protocols tailored for use in different body regions (e.g., renal arteries, peripheral vessels). Inline subtraction and inline maximum intensity projection (MIP) further simplify the workflow.

For non-contrast MR angiography, Siemens currently offers two techniques under the umbrella *syngo* NATIVE – *syngo* NATIVE TrueFISP and *syngo* NATIVE SPACE.



Renal Angiography,
3D NATIVE TrueFISP FatSat,
MIP and VRT, GRAPPA 2;
MAGNETOM ESSENZA
Tateyama Hospital, Tateyama, Japan





Angio Dot Engine

The Angio Dot Engine is designed to empower the user to perform high spatial resolution contrast-enhanced MR angiography. This can often even be achieved using optimized protocols for low dosed contrast medium acquisitions. The timing of the contrast medium in MRA is a particular challenge. The Angio Dot Engine assists the user in achieving the optimal timing for contrast arrival, easily and consistently, and provides an interactive approach to contrast timing.



After a simple click the localizer and vessel scout are acquired and loaded into the Graphical Slice Positioning (GSP). The next workflow step opens a customizable Guidance View that visually explains how to set up the test bolus measurement correctly. According to the instructions, the test bolus slice can be adjusted in the GSP. The planning of the test bolus is completed by simply clicking on apply.

TimCT Angio Dot Engine



TimCT Angio Dot Engine employs the revolutionary TimCT – Continuous Table move – technology for a large field of view in angiography examinations with the smooth workflow and the most homogeneous image quality. Thanks to the streamlined and automated workflow, TimCT Angio Dot Engine supports short acquisition times. A complete peripheral vessel runoff exam can be performed in less than 15 minutes with optimal bolus timing.

The TimCT Angio Dot Engine offers optimized protocols for peripheral vessel runoff exams. It allows CT-like scanning with MRI. There is no need to plan multiple steps and no need to plan overlapping sections.

TimCT Angiography,
3D FLASH ce-MRA,
MIP, GRAPPA 3;
MAGNETOM Aera
*University Hospital,
Essen, Germany*

Cardiovascular sequences

syngo Beat

syngo BEAT can simplify cardiac MRI significantly. Now you can diagnose cardiovascular disease faster and more easily. Achieve excellent results, even in difficult patients, from the smallest to the tallest. Improves treatment planning and introduce CT-like scanning to CMR with 3D and 4D exams.

Advanced Cardiac Package

Special sequences and protocols for advanced cardiac imaging, including 3D Cine, 3D Viability, Tagging, 3D Coronaries, and Multi Echo imaging among other specialized techniques as well as 4D functionalities. Allows comprehensive exams for cardiac experts.

syngo Interactive RT

Interactive cardiac real-time imaging.

syngo Flow Quantification

Special sequences for quantitative flow exams.

syngo TWIST

3D MRA to achieve high spatial and temporal resolution with minimal amount of contrast agent and no venous contamination.

syngo NATIVE

Contrast-free MRA with tailored protocols for different body regions.

syngo TimCT Angiography

Revolutionary TimCT Continuous Table movement technology, for smooth workflow and homogenous image quality of vascular examinations covering extended FoV's, up to the whole body.



Don't miss the wealth of clinical information on cardiovascular MRI at

www.siemens.com/magnetom-world

Cardiovascular applications

***syngo*.MR General Engine**

Software for professional and routine MRI reading usage. Includes workflows for dedicated MRI examinations that load and structure examination results automatically into meaningful layouts including user support to make sure that no data is missed. Contains several MRI radiology workflows, cardiovascular workflows and MR evaluation features.

Includes: *syngo*.MR Cardiac Reading
syngo.MR Angio Reading

***syngo*.MR Cardiac 4D Ventricular Function**

Automated evaluation and quantification of cardiac function for the left and right ventricle.

syngo*.MR Cardiac Flow

Automated blood flow evaluation for calculation of parameters, color-coded display and improved background phase correction.

syngo*.MR composing

Composing of images from different body regions to see the complete anatomy (also automated as Inline functionality).

Dedicated offline application for creation of full-format images from overlapping MR volume data sets acquired at multiple stages. Can be used to compose images in any of the other *syngo*.via workflows.

***syngo* Vessel View**

Automated analysis tool for MR angiography data for small and large vessels. Supports automatic quantification of stenoses and evaluation of aneurysms – for potentially faster diagnosis of vascular disease.

***syngo* Argus Dynamic Signal**

Evaluation software for automated image analysis of dynamic studies in the body. Automated contouring, motion correction and easy-to-use editing tools to quantify regional changes in the tissue based on signal-time curves.

* *syngo*.MR Cardiac Flow and *syngo*.MR Composing are not commercially available. Due to regulatory reasons their future availability cannot be guaranteed.

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Titel image courtesies, from left to right:

Cardio Viability, FLASH IR post contrast, GRAPPA 2; MAGNETOM Aera
Centre Cardio Thoracique de Monaco, Monaco

Thoracic Angiography, 3D FLASH ce-MRA TWIST, VRT, GRAPPA 3; MAGNETOM Skyra

Carotids Angiography, 3D FLASH ce-MRA, MIP, GRAPPA 2; MAGNETOM Verio
Seoul National University Hospital, Seoul, Republic Korea

Cardio Pefusion, Turbo FLASH post contrast, Map Slope, GRAPPA 2; MAGNETOM Avanto
Northwestern Memorial Hospital, Chicago, USA

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