syngo Native – Non Contrast MR Angiography Techniques

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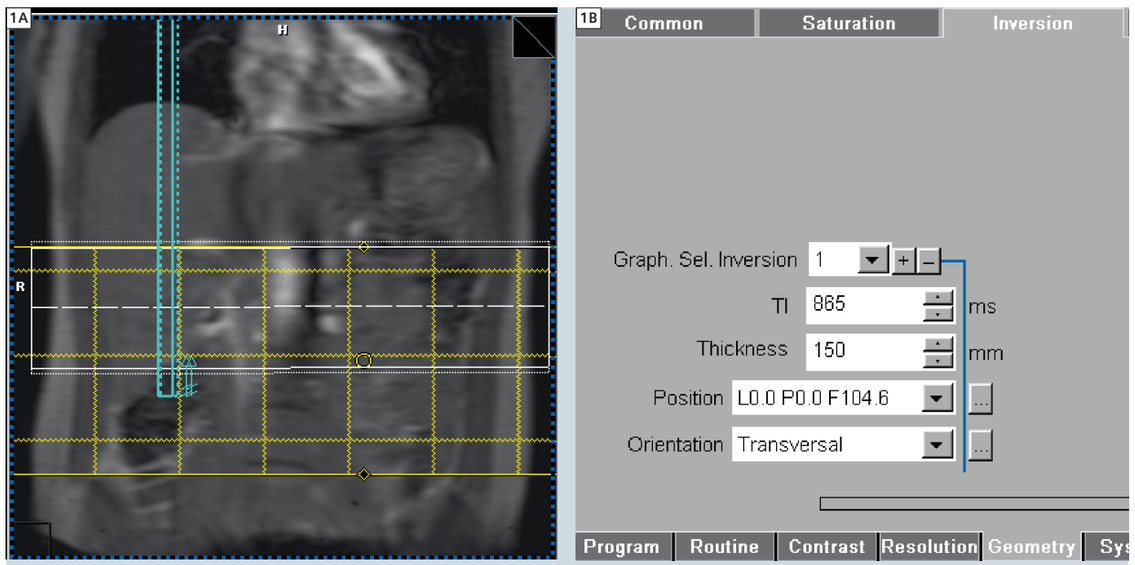
With the need to carefully consider the risk vs. benefit of contrast agent administration with the advent of Nephrogenic Systemic Fibrosis (NSF), as well as the need to perform cost effective MR studies, there is a demand for improved methods for performing angiography using intrinsic rather than extrinsic contrast mechanisms.
To address this need, with the release of software version *syngo* MR B17 comes *syngo* Native encompassing two new methods of non contrast MRA exploiting new methods for generating angiographic contrast.
The two varieties of Native are Native TrueFISP and Native SPACE – the former being more appropriate for abdominal imaging and the latter for peripheral arterial evaluation.

syngo Native TrueFISP

syngo Native TrueFISP is a new technique which enables the visualization of blood which flows into a vascular territory after preparation of the imaging volume with an inversion recovery pulse.
The sequence is derived from the 3D TrueFISP sequence which is regularly used for coronary angiography and has the benefit of 1D PACE for respiratory synchronization. Alternatively the respiratory cushion can be used which allows more flexibility and choice in the method of synchronization.
If 1D PACE is used ECG triggering can be added for additional improvements in image quality.



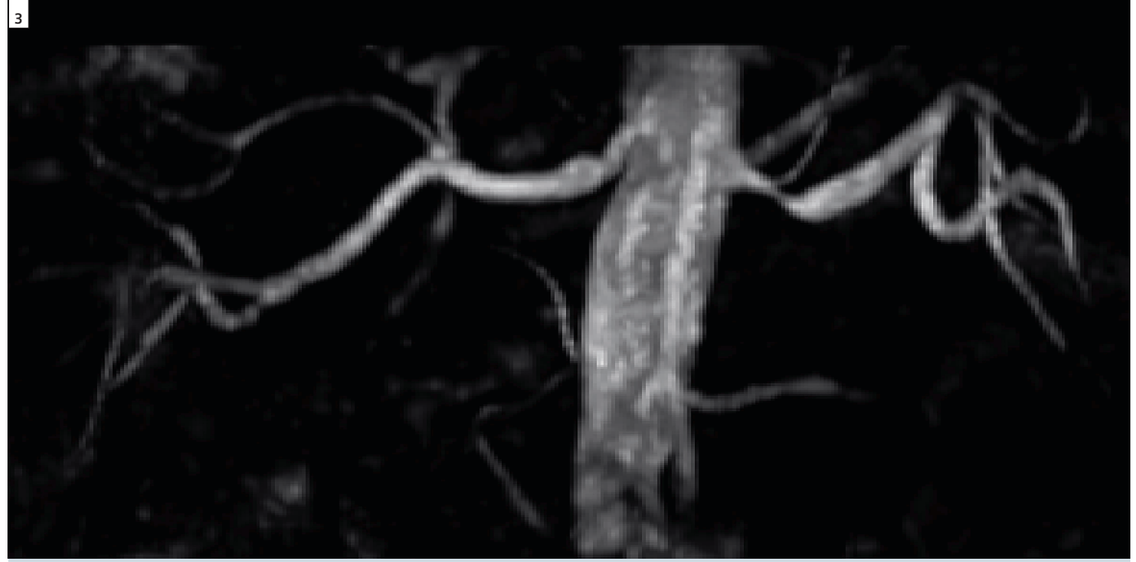
1 The *syngo* Native TrueFISP regional saturation with control of inversion time and geometry for up to four independent graphically positioned inversion preparation regions. The new graphic elements depicting the position of the inversion region are also shown.

2 Coronal 3D *syngo* Native TrueFISP with freely positionable inversion preparation positioned over the renal arteries – an additional inversion preparation area was positioned inferior to reduce signal from the inflow of non-inverted blood in the IVC. Spatial resolution 1.3 x 1.2 x 0.9 mm (65% slice resolution). Total scan time with 1D PACE (efficiency 38%) – ECG Gated.
Total scan time 5:30 min.
In this subject with good cardiac output a successful result is achieved with an Inversion time of 850 ms.

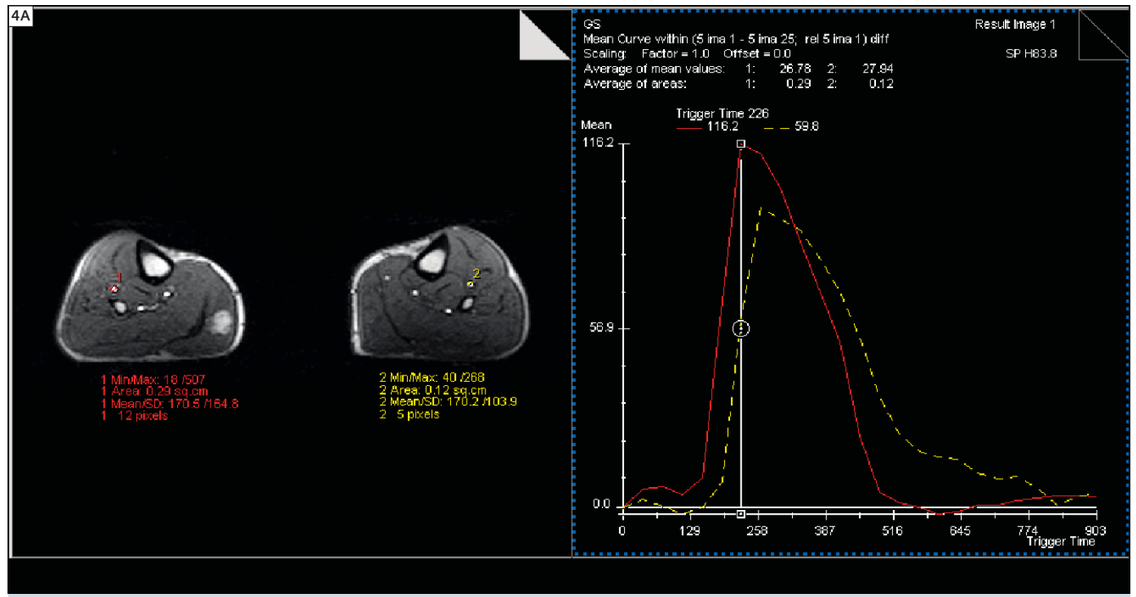
Native TrueFISP introduces a novel element to the user interface for *syngo* MR – regional inversion preparation. In a similar manner to regional saturation, the user can now use freely positionable regional inversion preparation (Fig. 1). Up to four different inversion preparation regions can be prescribed – this flexibility means that the user can tailor the preparation to different approaches and to different vascular territories. The sequence flexibility allows 2D and 3D approaches and various different methods for labeling the inflowing blood – for example by inverting either the inflowing blood or the vascular bed into which it is flowing.
Many of these new approaches remain to be explored and we expect that, in the near future, many variations of this method will appear as the possibilities become clear.
Until now the main application of Native TrueFISP has been the evaluation of abdominal arteries, particularly the renal arteries. It has also been shown to be a good method for evaluation of transplanted kidneys where the lack of motion enables the scan to be completed quickly – a time efficient method for evaluating these patients where other methods may be contraindicated.
The basic method behind the generation of contrast is that the vascular territory of interest is inverted and during the inversion time there is inflow of non-inverted blood. This blood gives rise to a high signal when the TrueFISP scan is executed after the inversion time.
This reliance on in-flow means that the method requires consideration of additional inputs into scan optimization, for example, a relatively healthy 25-year-old patient with good cardiac function would most likely fill the renal arterial tree with the blood ejected within a single heart beat. However, in an elderly patient with heart failure, the volume of blood available to fill the vessel of interest most likely will be smaller and in these patients more careful planning of the inversion preparation and extended inversion times, to allow longer for inflow, may be necessary.
syngo Native TrueFISP is a flexible method and can be applied to many vascular territories. The underlying limiting factor in this method is the volume of blood entering the inverted target region within an inversion time. The maximum inversion time which can be used is limited by the recovery of the magnetization of the targeted area – in practice this means a maximum TI of around 1400 ms can be used without intolerable loss of contrast.
The use of this technique has been successfully applied in renal angiography as well as in the assessment of transplanted kidneys to rule out anastomotic stenosis [1, 2].

syngo Native SPACE

The second new angiographic method introduced with *syngo* Native is Native SPACE. This approach exploits the difference in signal between data acquired when blood flow is minimal and when it is maximal. The Native SPACE user interface allows two sequential measurements of a high resolution 3D SPACE sequence with different ECG trigger times. Inline subtraction and maximum intensity projections allow a seamless workflow. Scan planning and processing



3 *syngo* Native TrueFISP performed in an arteriopath patient with bilateral renal artery stenosis. *(Courtesy of Dr. G. Houston, S. Gandy, Ninewells Hospital, Dundee, Scotland)*



4 Cross sectional cine imaging in the region of interest allows determination of times of maximal and minimal flow within the cardiac cycle. This information can also be useful in determining the presence of asymmetric flow or complete absence of pulsatility which would decrease the likelihood of successful visualization of the vessel in this area.

is very similar to current angiographic techniques. Typical scan times are around three to four minutes per anatomical location (depending on heart rate). Success with *syngo* Native SPACE depends on the accurate identification of the fast and slow flow times in relation to the trigger source (typically ECG is used). This is easily achieved with a simple cine FLASH sequence which is performed with the slice oriented perpendicular to the flow direction. Evaluation of this in "Mean Curve" allows precise detection of the fast and slow flow periods which can be used directly as input into the trigger delay times for fast and slow flow (Fig. 4).
The contrast generating mechanism, therefore, depends on the maintenance of a degree of pulsatility in the vessel of interest – if this disappears or is significantly attenuated the method may be challenging. However it seems that in many cases of chronic ischemic disease pulsatility is maintained to a sufficient degree, even in collateral vessels, to generate sufficient contrast.
It should be kept in mind that there may be cases where the pulsatility which this technique relies on may not be present – in which case the visualization of the vessel of interest may not be possible.

Summary

syngo Native SPACE and *syngo* Native TrueFISP are complimentary methods for MR angiography. Native SPACE being more appropriate in areas where large fields of view are required and where the area of interest is stationary (to accommodate the subtraction necessary for this method). Native TrueFISP is more suited to imaging of abdominal vessels where the integration of respiratory and cardiac synchronization can be of benefit. Native TrueFISP is a targeted method where the vascular anatomy which is demonstrable is determined by the volume of blood entering the prepared territory whereas Native SPACE requires pulsatility in the vessel to visualize it. An understanding of the basic contrast mechanisms will enable appropriate choice of sequence and appropriate choice of scan parameters to produce optimal image quality.

5 Maximum intensity projection of composed three-station study. Typical achievable resolution is 0.9 x 0.9 x 1.5 mm with scan times around three to four minutes per station, depending upon heart rate.

References

1 Non-Contrast Enhanced Renal MR Angiography Using NATIVE TrueFISP Initial Experience for Clinical Imaging of Patients with Renovascular Disease <http://cds.ismrm.org/protected/09Presentations/404/>. S Gandy et al Oral Presentation 404, ISMRM 2009. Hawaii.

2 Renal transplant: nonenhanced renal MR angiography with magnetization-prepared steady-state free precession. Liu et al. Radiology. 2009 May;251(2):535-42.

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