syngo NATIVE TrueFISP in the Assessment of the Transplanted Kidney

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Introduction

Assessment of the vascular integrity of a transplanted kidney is a request we receive occasionally, most commonly when transplant recipients present with compromised renal function.
The fact that the patient presents with impaired renal function and has recently undergone transplant surgery makes the nephrologist understandably nervous about referring them for contrast-enhanced MR Angiography of the transplanted kidney. While the risk may be small, it makes sense to use a completely non-invasive method without the potential risk of Nephrogenic Systemic Fibrosis, if the diagnostic yield can be sufficient to answer the clinical question.
In our institution we recently published a study [1] where the effectiveness of TrueFISP with selective inversion recovery preparation, now known as *syngo* NATIVE TrueFISP, was evaluated for its utility in the assessment of the transplanted renal artery. Our results showed that the technique was essentially the same in diagnostic performance as low dose contrast-enhanced angiography and the method provides a low-risk method for the initial evaluation of the transplanted kidney.

Principles

syngo NATIVE TrueFISP is a method which generates angiographic contrast by preparing the region which contains

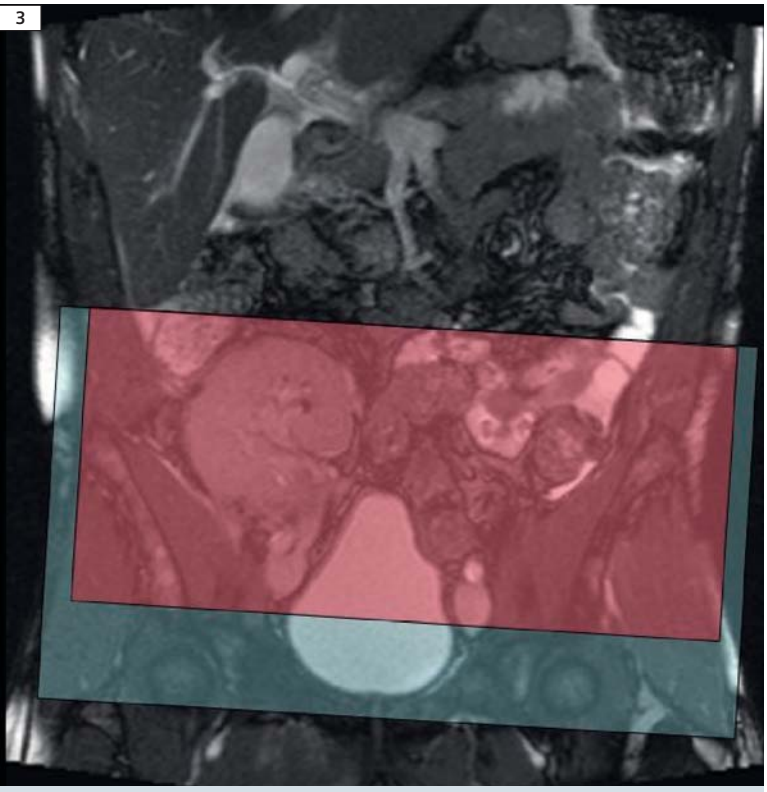
1 Volume rendered depiction of the anastomosis and proximal branches in this transplanted kidney. A slight "waisting" is seen at the site of the anastomosis.

2 Thin MIP (50 mm) demonstrates the anastomosis and the upper pole accessory / early branching artery which originates very close to the site of the anastomosis. Depiction of 2nd and 3rd order branches of the renal artery provides qualitative evidence of good perfusion as the mechanism behind this technique relies upon in-flow during the prescribed inversion time. In this case blood depicted at the distal ends of the demonstrated arteries has travelled from the top if the inversion band (essentially top of this image) within 900 ms.

the vascular territory of interest by use of a selective inversion recovery pulse. The inversion pulse reduces the signal from the static tissue and blood which remains in the area but blood which flows into the slice during a defined inversion time is not inverted and, when the image data (3D TrueFISP) is collected there is a large difference in signal between blood which has moved into the area and other tissues which remain attenuated as a consequence of the inversion preparation.
This preparation region is not simply slice selective but has a graphically positioned inversion preparation which allows targeting of the desired vessel, independent of the orientation of the imaging volume.

Case study

A 64-year-old male patient with hypertension and type-2 diabetes who had been the recipient of a transplanted kidney was referred for evaluation of the transplanted renal artery to rule out an anastomotic stenosis as a cause for diminishing renal function. Recent Doppler ultrasound had demonstrated elevated velocities in the transplant renal artery, raising the suspicion of transplant arterial stenosis.
The patient and referring physician had concerns relating to the administration of Gadolinium containing contrast agents as his eGFR was reduced (35 ml/min/1.73 m^2). 30 ml/min/1.73 m^2 is the cut off point for administration of contrast in our institution.
After localization with 2D HASTE images the imaging volume of the *syngo* NATIVE TrueFISP protocol was positioned to depict the iliac arteries and the renal transplant anastomosis. The selective inversion band was positioned transversely with its upper border a few cm proximal to the assumed position of the anastomosis. The inversion preparation was larger than the imaging volume in the superior-inferior direction and covered around 4 cm distal to the imaging volume to invert any inflowing blood in the iliac veins (Fig. 3).
In this case, we used ECG triggering but in practice this is largely optional for renal transplants. We have found that the degree of respiratory motion in the pelvic region is small enough so as not to be a significant source of artifact in most patients, where the transplanted kidney is positioned against the pelvic sidewall and largely free of any significant respiratory motion.
The spatial resolution of this protocol was 1.25 x 1.25 x 1.25 mm (interpolated to 1 mm in the slice direction). 112 slices per 3D slab were acquired giving just over 11 cm of head-to-foot coverage. An inversion time of 900 ms was



3 In this example the inversion preparation (gray) was positioned asymmetrically in the head-foot direction in relation to the imaging volume (red) to reduce the signal from any inflow via the iliac veins.

4 A cross sectional thin MIP of the iliac artery at the level of the anastamosis showing the main renal artery demonstrates a minor degree of narrowing which is probably of limited hemodynamic significance as the artery is well seen with 2nd and 3rd order branches well seen.

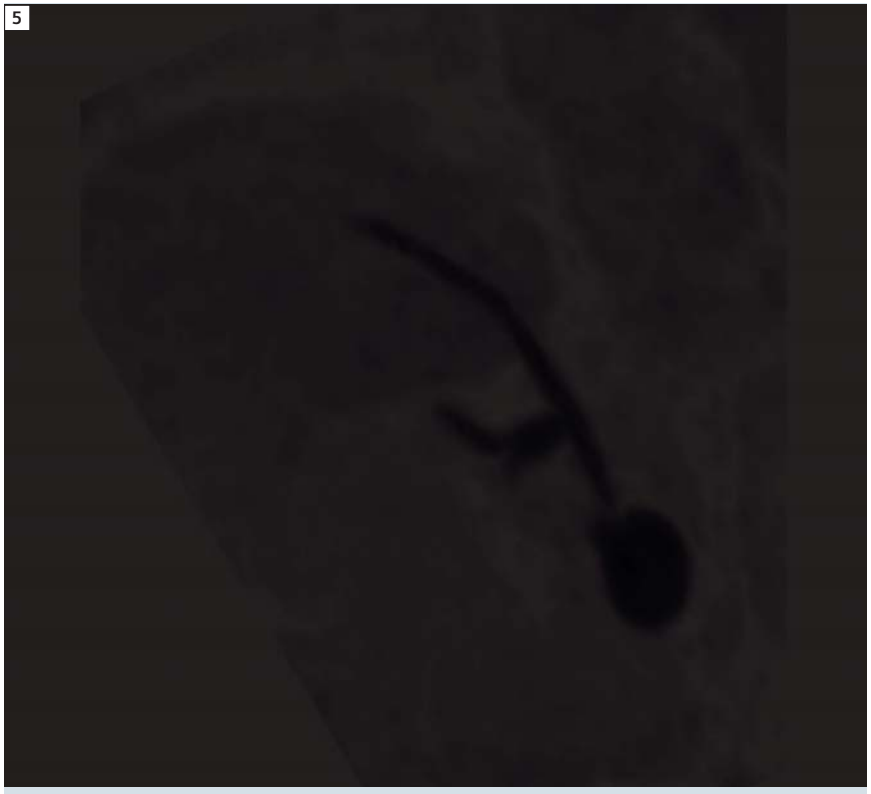
used which allowed the TI and acquisition to be completed within one heart beat resulting in completion of the scan in 3 minutes.
The TrueFISP readout scheme used a flip angle of 90 degrees.

Findings

The renal artery to external iliac artery anastomosis was well demonstrated and depicts a mild stenosis which is probably not a factor in this patient's diminishing renal function (Fig. 2).
The upper pole accessory artery (or what was probably an early branching upper pole artery in the native kidney) is also well seen distally, though the spatial resolution of this protocol inhibits the confident depiction of this very small vessel to the degree where an assessment of its diameter or severity of stenosis can be given.
The physiological nature of the contrast mechanism in NATIVE TrueFISP, however, gives some indication that this branch does not have a hemodynamically significant stenosis as the upper pole branch is filled with fresh blood within one cardiac cycle.

Conclusion

syngo NATIVE TrueFISP is a technique which allows depiction of the anastomotic site of a transplanted renal artery and the major branches of the implanted organ.
The mechanism whereby the angiographic contrast is generated in this sequence has a physiological component which can be seen as both a positive and a negative feature.
In the absence of sufficient flow, or in significantly impaired flow, the lumen of the vessel of interest may not be filled with sufficient "non-inverted" blood. This can be addressed to a degree by careful planning of the position of the inversion region so that large volumes of blood proximal to the vessel of interest are not inverted, which will reduce the available contrast.
In the example of renal transplants, if blood flow is compromised, the inversion preparation can be targeted so that the proximal external iliac artery is outside the preparation region, so that the non-inverted blood which gives the required signal has less far to travel – so less "fresh blood" is wasted filling a vessel of no clinical significance. Increasing the inversion time may also help in depiction of arteries where inflow into the kidney is reduced.
The physiological nature of the contrast mechanism is a benefit in that it gives a qualitative feel to the significance of any demonstrated stenosis.
In this example the mild stenosis seen at the anastomosis seems to have no significant effect on the filling of the distal branches of the intra-renal arteries suggesting that the kidney is well perfused.
syngo NATIVE TrueFISP is a useful addition to the available methods for performing MR angiography. As with all techniques a full understanding of the mechanisms behind the technique will give more consistent results and provide additional diagnostic information.



5 The upper pole accessory artery is well demonstrated, though the assessment of the lumen of this very small artery at the site of the anastomosis is somewhat compromised due to spatial resolution limitations.

References

1 Liu X, Berg N, Sheehan J, Bi X, Weale P, Jerecic R, Carr J. Renal transplant: nonenhanced renal MR angiography with magnetization-prepared steady-state free precession. Radiology. 2009 May;251(2):535-42.

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