Pre-Transplant Assessment of Potential Renal Donors with *syngo* Native True-FISP: Case Study and Initial Experience

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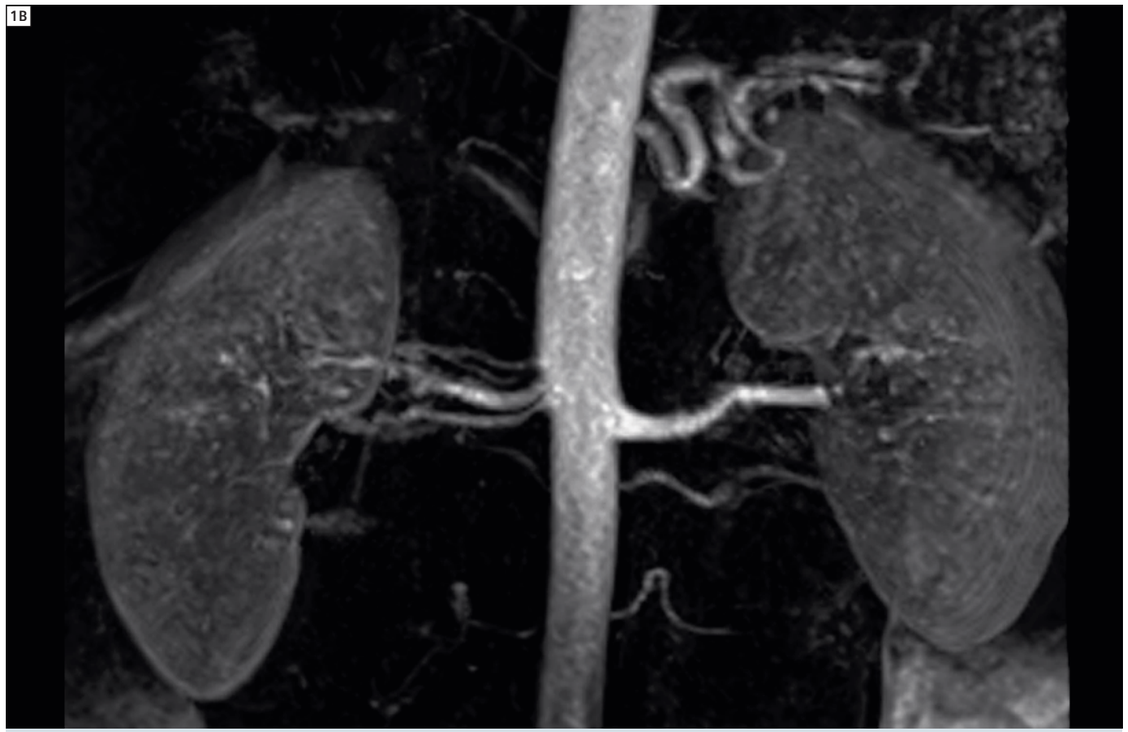
Background

At our institution, people who are willing to donate a kidney to a patient with end-stage renal disease undergo a rigorous pre-operative evaluation. In addition to psychological testing, counseling, and a complete panel of laboratory studies, the work-up includes an MR angiography (MRA). Since potential donors are generally young, healthy individuals, the primary purpose of the MRA is not to screen for atherosclerotic disease, but to provide a detailed map of the renal arteries. The intention is not only to protect the healthy donor from harm, but also to ensure that the chosen kidney will be up to the task of sustaining the patient in whom it will be placed.
Anatomic variants of the renal vasculature are very common, and have the potential to complicate a minimally invasive operation where the surgeon's field-of-view is limited. For example, the kidneys are often supplied by more than one artery, with accessory vessels occasionally originating as far afield as the common iliac arteries. Vessels can enter the kidney through the poles, rather than through the hilum. And even single arteries can bifurcate or trifurcate very quickly, well before they reach the renal hilum, and could be cut as the kidney is harvested.
Precise pre-operative knowledge of a donor's vascular anatomy is critical to the success of a renal transplant. Failure to predict and prepare for these kinds of variants can be disastrous since associated bleeding may be difficult to control and transection of an artery could lead to partial or even complete devascularization of the precious kidney, completely sabotaging the whole enterprise.
The donor will then have lost a kidney without a benefit to anyone.
The MRA is used during the first phase of the work-up to determine whether the donor actually has a suitable kidney, ruling out morphologic variants like horseshoe kidney or crossed-fused ectopia as well as renal malignancy. The arterial anatomy will largely determine the next phase of decision-making, for example, which of the kidneys should be harvested, and the appropriate surgical method. If there is no good alternative, some surgeons will accept a kidney with a dual blood supply and plan the operative approach accordingly. Some smaller vessels can, if necessary, be sacrificed. But, again, the surgeons have to be prepared to locate these via a more extensive dissection than would be required for a single artery.
Conventional contrast-enhanced MRA (ceMRA), however, is frequently suboptimal for this purpose. Image quality can suffer due to poor bolus timing, injector malfunction, patient motion, or obscuration of detail due to early filling of renal veins. Consequently, we have incorporated the *syngo* Native TrueFISP sequence into our routine MR protocol for renal donors. The technique often salvages an otherwise suboptimal conventional ceMRA. In addition, because venous contamination and tissue enhancement are strongly suppressed in the Native TrueFISP, the entire course of the renal artery is usually demonstrated very cleanly, with excellent visualization of the intrarenal arteries as well.

1A

1A Routine MR work-up of a potential kidney donor. **(1A)** This maximum intensity projection (MIP) image from an axial volumetric *syngo* Native TrueFISP acquisition reveals a cluster of renal arteries arising in close proximity to each other, as well as an accessory left renal artery (arrowheads). Early branching vessels are also documented bilaterally (arrows), with the one on the left coursing directly to supply the upper pole.

1B

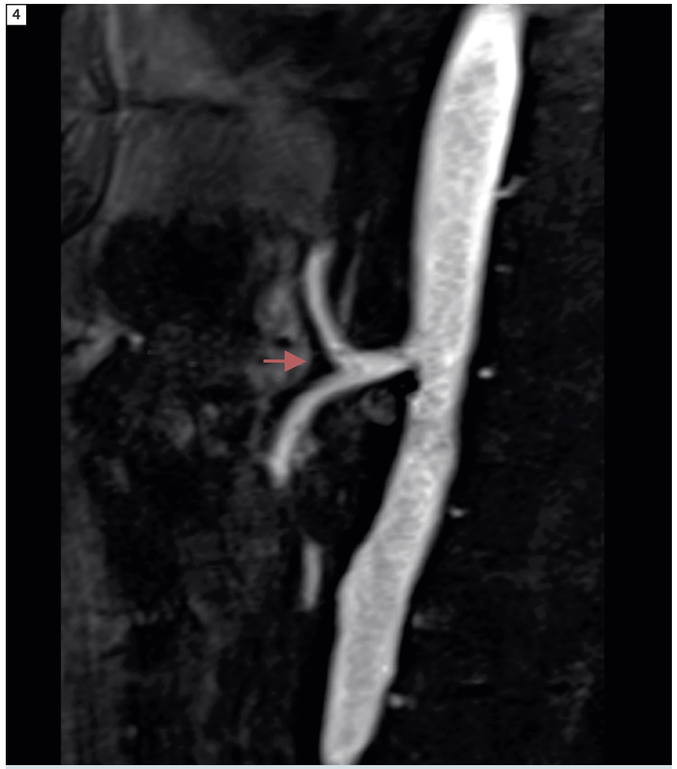


1B This vessel is nearly undiscernible on the conventional MRA, probably due to the subtle horizontal band of motion artifact passing through both kidneys. Further, the distinct elements of the group of renal arteries on the right are not as clearly depicted, and the branching is likewise obscured.

2A Another potential renal donor. **(2A)** Coronal MIP image reconstructed from an axial *syngo* Native TrueFISP acquisition clearly demonstrates the 2 bilateral renal arteries. The more inferior vessels (arrowheads) are smaller and could easily occlude if the decision was made to harvest one of these kidneys. Early bifurcation of the main right artery (arrow).

2B A MIP image from a conventional coronal MRA acquisition shows significant venous contamination, with obscuration of some arterial segments.

3 Coronal MIP reconstruction of a *syngo* Native TrueFISP data set in pre-operative work-up for renal tumor. The image lays out the intrarenal arteries quite well, without obscuration by the early parenchymal enhancement that often contaminates contrast-enhanced MRA. The technique clearly has potential to rule out fibromuscular dysplasia in the distal portion of the main arteries. It could also prove useful in the search for the tiny intrarenal aneurysms of polyarteritis nodosa.



4 48-year-old woman with chronic abdominal pain who is also allergic to contrast agents. The examination was undertaken to exclude significant disease in the mesenteric vessels. The source images for this sagittal MIP through the upper abdominal aorta were actually acquired in the sagittal plane, for optimal visualization of the celiac and SMA ostia. Clearly, significant atheromatous disease is excluded, but the common celiac-SMA trunk, a normal variant, is nicely demonstrated (arrow).

Case study

A healthy 31-year-old male would like to donate a kidney to his father. The renal transplant service requested an MRA as part of the customary pre-transplant evaluation for potential donors.

Sequence details

The renal arterial anatomy of this patient was imaged first with *syngo* Native TrueFISP followed by conventional ceMRA. The Native TrueFISP volume was acquired in the axial plane, 120 slices with 1 mm through slice resolution. The acquisition was fat suppressed at a TR/TE = 878/1.8 ms and a flip angle of 90 degrees. A PAT factor of 2 was used with one average. Acquisition time was 3:10 min. Images have been aquired using our 1.5T MAGNETOM Espree with Spine and Body Matrix coils.

Imaging findings

The donor in question has very complex arterial anatomy, with four arteries supplying the right kidney, all arising from the aorta in close proximity to each other (Fig. 1). There are only two arteries on the left, but the superior artery quickly gives rise to a branch vessel that courses outside the hilum to enter the kidney through the upper pole renal tissue. Even with prior knowledge of this branch vessel from the *syngo* Native TrueFISP images, it was still not clearly delineated on the MRA, which is degraded by venous contamination and a band of horizontally-oriented pulsation artifact. This patient was ultimately rejected as a suitable donor. Harvesting would have been difficult and implantation into the recipient would have been even more challenging. Moreover, the small size of the branch vessel dramatically increased the likelihood of eventual stricture or thrombosis at the anastomosis.

Discussion and other examples

Figure 2 illustrates another example of duplicated renal vessels, with the *syngo* Native TrueFISP adding value to the information provided by the conventional MRA technique. Yet another potential application for the non-enhanced technique stems from its capacity to depict the intrarenal arteries in detail (Fig. 3). This ability is quite robust, as long as the patient's cardiac output is good and patient motion is minimized. If output is low or if the patient is dehydrated, signal will fall off rapidly as the aorta descends. Consequently, a significant limitation to aortic blood flow should discourage the radiologist from committing to a stand-alone Native TrueFISP for renal artery assessment. The technique's Z-axis limitations also dictate very careful placement of the acquisition volume, with its superior margin just above the vessels in question.
Figure 4 represents a change of the source acquisition to the sagittal plane for this scan designed to rule out atherosclerotic disease or clot in the larger arteries of the bowel mesentery. These images have been acquired using our 1.5T MAGNETOM Avanto with Spine and Body Matrix coils.

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