Contrast-Enhanced MR Angiography at 3 Tesla for the Assessment of Vascular Complications of Pancreas Transplantation

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Introduction:

Pancreas transplantation is a definitive treatment for diabetes. Despite improvements in surgical technique vascular complications frequently result in transplant necrosis and necessitate transplant removal. Successful surgical and endovascular treatment has been described for a number of these entities, but timely diagnosis is essential for graft survival. Clinical diagnosis of transplant dysfunction is relatively insensitive and nonspecific. The role of MRI at 1.5T has been previously investigated in this clinical setting and it was shown that dynamic contrast enhanced MRI and MRA allow detection of acute transplant rejection, allograft infarction, and assessment of the allograft vasculature (1-6). No data exist for 3T systems. The purpose of this study is to evaluate high spatial resolution ceMRA at 3T for the assessment of vascular complications of pancreas allografts.

Methods:

Clinical and MR angiographic findings were reviewed in 8 patients (6 males, 2 females patients; mean age 47.6 years; range 36-64 years) with a history of pancreatic transplant dysfunction who underwent a total of ten ceMRA studies. All imaging studies were performed on a 3T scanner (Trio, Siemens Medical Solutions, Malvern, PA) using a 6 channel body matrix coil. A sequential 3D FLASH sequence was used with an excitation flip angle of 23°. Sequence parameters: matrix size 384×384; TR/TE 2.92/1.18 ms; FOV 400 mm; receiver bandwidth 590 Hz/pixel, parallel imaging (GRAPPA) acceleration factor 3. A minimum of two image acquisitions were performed in order to acquire arterial and venous phase images. Acquisition time for one dataset was 20 seconds and the spatial resolution was 1.0 x 1.0 x 1.2 mm uninterpolated. 20ml gadobenate dimeglumine (Multihance; Bracco Imaging, Milan, Italy) were injected at 2.0 ml/sec with a power injector. Injection delay was calculated for peak arterial enhancement during the acquisition of the central lines of k-space for the first acquisition. Angiographic comparison was available for two MRA's. Image analysis of arterial segments was performed by two observers in consensus, blinded to the clinical results. Overall image quality, contrast bolus timing and the presence of artifacts were assessed qualitatively on a four point Likert scale. (Image Quality: 1 = excellent = interpretability sufficient for treatment planning, 2 = good= minor impairments in image quality fully sufficient for treatment plan, 3 = poor = some impairment of image quality, but sufficient for treatment planning and diagnostic, 4 = non-diagnostic = not sufficient for treatment planning; Bolus Timing: 1 = excellent = pure arterial phase enhancement without venous contamination allowing delineation of all relevant arterial structures, 2 = good predominant arterial enhancement with minimal venous contamination allowing identification of all arterial structures, 3 = fair predominant arterial enhancement with significant contamination allowing identification of all major arterial structures but not side branches, 4 = poor = poor arterial enhancement and/or severe venous contamination resulting in non-diagnostic study ; presence of artifacts: 1 = absent, 2 = present, not affecting image interpretation, 3 = present, affecting image interpretation, 4 = severe, rendering study nondiagnostic). Pancreatic parenchymal enhancement was assessed according to qualitative criteria proposed by Krebs et al (1): 1 = homogeneous and normal enhancement, 2 = inhomogeneous enhancement, 3 = decreased enhancement and 4 = absent enhancement. For the patients with DSA correlation visibility and patency of the lumen of the arteries supplying the transplants and their respective anastomoses were assessed on a workstation in a semiquantitative fashion on a graded scale. (1 = completely visualized and patent, 2 = completely visualized and 50% or less stenosis or filling defect, 3 = completely visualized and more than 50% stenosis or filling defect, 4 = completely visualized and complete occlusion, 5 = not visualized). The following vascular segments were assessed: recipient: distal aorta, common, external and internal iliac arteries; transplant: iliac Y-graft (where applicable), splenic artery and superior mesenteric artery as well as the respective anastomoses.

Results:

All exams were of diagnostic quality. The overall image quality was ranked as excellent in almost all studies (mean rank 1.1, SD = 0.32). Contrast bolus timing was ranked excellent in all cases (mean rank 1, SD = 0). There was a remarkable paucity of artifacts (mean rank 1.1, SD = 0.32). 9 studies showed no artifacts and in one study respiratory motion artifact was present but did not affect image interpretation.

In all 10 exams vascular complications, signs suggestive of rejection or other parenchymal abnormalities were detected. None of the studies was considered normal. 3T ceMRA allowed assessment of parenchymal enhancement in all cases with 4 cases showing decreased enhancement, 4 showing inhomogeneous enhancement in only 2 showing homogenous and normal enhancement. The MRA findings were concurrent with the final clinical diagnosis in all cases. All major vascular complications were detected and included complete or partial arterial graft occlusion / thrombosis, complete or partial venous thrombosis and arterial stenoses. Angiographic comparison was available for 22 arterial segments / anastomoses in two examinations. For the arterial segments in these exams, ceMRA correctly identified 7 segments with complete occlusion (Figure), two with partial stenosis > 50% (grade 3) and 13 segments without disease. There was complete concordance between 3T MRA and DSA.

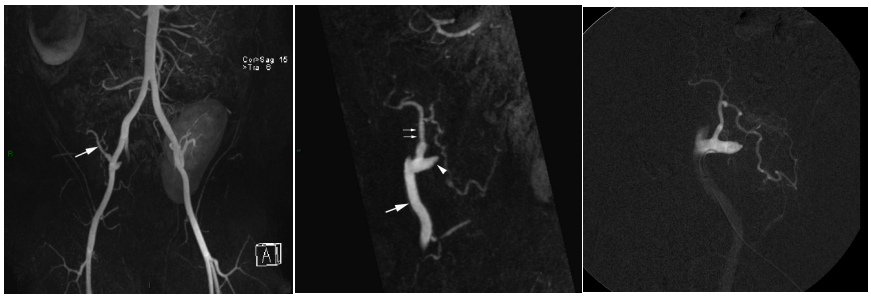

Figure: 47 year old male patient 8 years after pancreas transplantation presenting with increased serum glucose. (left image:) MIP of 3T ceMRA shows a pancreas allograft in the right iliac fossa and kidney transplant in the left; patent splenic limb of Y graft is noted (arrow). (middle image:) Sub-volume MIP shows Y graft originating from external iliac artery (large arrow). The splenic limb as well as splenic artery are patent (two small arrows), the limb to the superior mesenteric artery as well as the SMA are occluded due to thrombosis (arrow head). (right image:) Selective digital subtraction angiogram confirms the MRA findings.

Conclusion: High spatial resolution MR angiography of pancreas allografts at 3T allows assessment of the arterial vascular anatomy with great accuracy and can be used to reliably identify clinically relevant vascular complications.

References

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