Its safety and accuracy make abdominal MR angiography an ideal choice for screening and diagnostic of the abdominal aorta and its major branches; however, spatial resolution is still lower than conventional angiography for the identification of distal branches and manual bolus time does not allow adequate timing with potential lack of arterial enhancement, multiple successively enhancing structures, including parenchyma and veins. This prospective study focuses on evaluation of image quality and degree of visualization of the aorta and the visceral arteries using an optimized 3D Flash CE-MRA.

INTRODUCTION

Since the early work of Prince et al [1], three-dimensional (3D) Contrast material-enhanced Magnetic Resonance Angiography (CE-MRA) has been incorporated into clinical practice. In general, 3D CE-MRA is a useful imaging method in cases of large vessel such as the aorta and its main branches, including the celiac, superior mesenteric, and renal arteries. However, depending on experimental parameters (sequence parameters, injection timing...), large results discrepancies can be found and MRA is still limited in demonstrating the distal branches of the celiac, mesenteric and hepatic arteries. The purpose of this study is to evaluate image quality, over a large population of patients, for visualization of the aorta and the visceral arteries by using high spatial resolution (512 base matrix), thin slices and optimized acquisition time on 3D Flash CE-MRA.

MATERIALS AND METHODS

3D MR breath-hold angiography was prospectively performed in 62 consecutive patients referred for hepatic, pancreatic or mesenteric diseases, between August 2000 and June 2001. All exams were performed on a 1.5 T Symphony system (Siemens, Erlangen, Germany) with 20 mT/m maximum gradient strength and a body phased array coil. We used a 3D Fast Low Angle SHot (FLASH) sequence with quick fat saturation performed in the coronal plane with the following imaging parameters: TR/TE 5.2/2 ms; 25° flip angle; 1.6 mm slice thickness; 192 x 512 matrix; 400 mm field of view, 80 to 100 mm slab thickness and about 26 sec acquisition time. Before MRA acquisition, a timing sequence was performed to determine the arrival time of the contrast material using a bolus of 2 ml of gadopentate dimeglumine followed by a flush of 10 ml of normal saline solution. The delay time between beginning of contrast media injection and start of acquisition sequence was calculated as follows: Delay time = arrival time - 3/8 acquisition time + 3 sec. The additional time of 3 sec was introduced to insure measurements reproducibility. The coefficient 3/8 applied to the acquisition time, correct for the asymmetric k-space sampling. 0.2 mmol/kg of body weight of gadopentate dimeglumine was intravenously administered as a bolus by using a power injector immediately followed by 20 ml of normal saline solution. The main quantitative parameter of interest was the intravascular signal-to-noise ratio (SNR) in the abdominal aorta, proximal portion of the celiac trunk and superior mesenteric artery. These measurements were performed on coronal source images. Qualitative image analysis was evaluated independently by two radiologists (YB, OP) and graded on a 1-5 scale (0 = no information, 1 = poor, 2 = good, 3 = excellent). Separate analyses were performed for the aorta, the celiac trunk, the common and the proper hepatic arteries, the intrahepatic arteries, the gastro-duodenal artery, the splenic artery, the left gastric artery (LGA), the superior mesenteric artery (SMA) and its branches, the inferior mesenteric artery (IMA), the pancreatico-duodenal arcades, and the renal arteries. Analyses were performed on coronal source images as well as thin Maximum Intensity Projection (MIP) with multplanar reformation. The reviewers also noted anatomic variations of artery vasculature. Based on radiologist scoring, statistical analyses were performed using Excel software (Microsoft, Redmond, Washington) and EPI info 6 (CDC Atlanta – ENSP, Rennes, France). Correlation coefficients with variance were estimated with homogeneity Bartlett test and Fisher – Snedecor. Inter-observer agreement was assessed by weighted Kappa analysis. Kappa index values K is defined as follow: excellent agreement: K>0.8; good agreement: 0.8>K>0.6; moderate: 0.6>=K>=0.41: poor: K<0.4.

RESULTS AND DISCUSSION

All patients tolerated well the MR examinations and were able to hold there breath during acquisition of the 3D data sets. The means SNR were respectively 56.2±15.2 for the aorta, 59.2±15.1 for the celiac trunk, 57±15.2 for the superior mesenteric artery with an homogeneous distribution (p=0.99). There was no statistical difference between the values Study variance confirmed the good vascular enhancement on a reproducible way. A pure arterial phase without any venous overlap was obtained for all the patients. Average score of vessel visualization on source images was good to excellent for proximal segments (aorta (2.93), celiac trunk (2.93), common and the proper hepatic arteries (2.61), superior mesenteric artery (2.77), and renal arteries (2.41)), bad to good for distal or small segments (intrahepatic arteries (1.84), gastro-duodenal artery (1.19), left gastric artery (1.58), branches of SMA (1.68), inferior mesenteric artery (1.02)] and bad for pancreatico-duodenal arcades (0.40). After thin MIP with multplanar reformation, the average score of distal segments was significantly improved (average score > 2). A gain for vessels depiction was noted in 80%. The overall agreement between the 2 reviewers in the visualization of definite artery segments was excellent (K>0.8). Anatomic variation of artery vascularisation was depicted in 52% of patients, a left hepatic artery arising from the LGA in 9 patients, a right hepatic artery (RHA) arising from the SMA in 5 patients, a RHA arising from the celiac trunk in 2 patients, a proper hepatic artery arising from the SMA in 2 patients. The advantage of gadolinium 3D MRA of hepatic, mesenteric and splenic arteries, was previously described in studies using a 512 base matrix and slice thickness between 2 and 3 mm. The main study [2] comparing MRA with conventional angiography found a good assessment for proximal segments but still recommended conventional angiography for distal arteries evaluation because of a poor MRA depiction. In our study, degree of visualization of the aorta and the visceral arteries was excellent, allowing a good depiction of distal arteries. Image quality was the combination of a good contrast material injection and high spatial resolution.

CONCLUSION

3D contrast MRA with a 512 base matrix and thin slices increases spatial resolution and highlights high vessels outlines. It’s a reproductive technique which can routinely substitute conventional angiography for celio-mesenteric evaluation.

REFERENCES
