"Shoot and Scoot" MR angiography: clinical experience in a symptomatic population with peripheral vascular disease.

J. M. Serfaty[1], J. P. Laissy[1], P. Aksit[2], E. Schouman-Claeys[1], P. Hervo[3]

[1]University hospital of Bichat, Paris, France, [2]Global Applied Science Laboratory, GE Healthcare Technology, Baltimore, Maryland, United States, [3]GE Healthcare Technology, Buc, France

Purpose:

To assess an improved version of the single injection multi-station bolus chase MRA technique known as "Shoot and Scoot" (SNS) [1] in a symptomatic population of patients with peripheral arterial occlusive disease of the lower limbs. By enabling a faster bolus chase, SNS promises to reduce venous contamination at infrapopliteal arterial vasculature while preserving spatial resolution compared to standard multi-station peripheral MRA methods, and preserving SNR compared to multiple injection approaches to imaging the peripheral vascular tree [2].

Introduction:

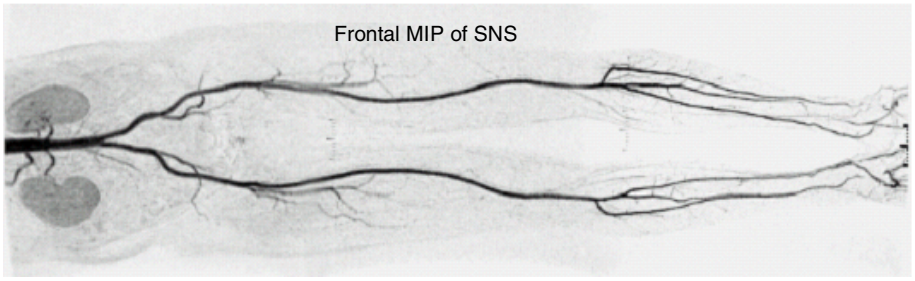
One of the major drawbacks of MR angiograms is venous return in the tibio-fibular area. Reduction of venous contamination requires an increase of the acquisition speed of the two first stations (compromising spatial resolution) or the use of multiple injections and separate acquisitions at the distal and proximal areas, which leads to a reduction of SNR due to residual enhancement in arteries from previous injections. We studied the potential of "SNS" technique to maintain high spatial resolution MR angiography of the lower limbs in particular in the calves with a single injection of contrast media.

Materials and Methods:

All images were obtained with a 1.5T Signa TwinSpeed (GE Healthcare, Waukesha, Wi, USA) with 40 mT/m gradients. 16 patients (1 female-15 male; average age 66 years, min 43 – max 87 years), symptomatic for peripheral vascular disease were imaged. Twelve patients were diabetic. The SNS MRA was performed with the integrated body coil at the aorto-iliac and femoro-popliteal stations, and with the 8-channel body array coil (USA Instruments) at the tibio-fibular station. A fast 3D RF phase spoiled gradient recalled pulse sequence was used in all stations with an elliptical centric acquisition order in all patients [3]. A total of 0.2 mmol/kg of gadolinium chelate was administered using an automatic power injector and a biphasic injection: 40% of the dose at 1.7 ml/s immediately followed by the remaining 60% at 0.7 ml/s flushed with 40 ml of saline. Real-time visual bolus detection was used to trigger the beginning of the acquisition. The technique used for MRA was a segmented k-space acquisition called "Shoot and Scoot" (SNS): During the first pass, only 50% of the data corresponding to the center of the k-space was acquired in the aorto-iliac and femoral stations while all of k-space was acquired in the tibio-fibular area. Acquisition of the outer data of k-space of the first and second stations was completed during a second pass. Data of the center and outer k-space were merged to reconstruct the final images. For each station, different obliquities, matrix sizes, number of partitions, and coil selection were possible [4]. The time to reach the distal station was 27 sec ± 1 sec, which was significantly shorter than the time of the conventional acquisition protocol, which is normally 55 sec for the same spatial resolution. Typical acquisition parameters were: for station 1 & station 2, TR/TE: 3.6/1.4 msec, FA: 30°, Bw: 83.3 KHz, Sl. thickness: 3.0 mm, 320x192 matrix, 0.5 NEX, FOV: 43 cm; Station 3, TR/TE: 4,4/1,2 msec, FA: 30°, Bw: 62.5 KHz, Sl. thickness: 2.4 mm, 448x320 matrix, 1 NEX, FOV: 43 cm. A subtraction from a pre-injection mask scan was performed on all stations.

Image evaluation:

Two radiologists did a consensual reading on each station. Arterial enhancement, artifact (sharpness of edges or motion artifact) deep venous return and superficial venous return were evaluated for each station according to a five-valued scale: 1- no arterial filling, very strong artifact or venous return 2- weak arterial filling, strong artifact or venous return 3- intermediate quality arterial filling, mild artifact or venous return 4- good arterial filling, little artifact or venous return not hindering interpretation 5- excellent arterial filling, no artifact, no venous return. Three patients were excluded from analysis due to inadequate positioning of 3D MRA FOV.



Results :

Aorto-iliac station: arterial filling was good or excellent with little or no artifact present in 94% cases, except in two patients rated 3 (intermediate quality arterial filling for the first, mild edge blurriness for the second). No venous return was noted.

Femoro-popliteal station: arterial filling was always good or excellent. Mild edge blurriness was observed in 2 cases and strong deep venous return in one case. This strong venous return didn't hinder interpretation. No superficial venous return was reported.

Tibio-fibular station: arterial filling was always good or excellent. One case (one leg) displayed an anterior popliteal artery with enhanced artery borders and central contrast void, and three cases had mild superficial venous return that didn't hinder interpretation. These later cases were noted in patients with large leg ulcers (enhancing arterio-venous anastomoses and rapid venous return). No deep venous return was reported.

Station	Arterial filling		Artifact		Deep venous return		Superficial venous return	
Quality Score	4-5	1-3	4-5	1-3	4-5	1-3	4-5	1-3
Aorto-iliac	94%	6% (score 3)	94%	6% (score 3)	100%	0%	100%	0%
Femoro-popliteal	100%	0%	88%	12% (score 3,3)	94%	6% (score 2)	100%	0%
Tibio-fibular	94%	6% (score 3)	94%	0%	100%	0%	82%	18% (scores 3,3,3)

Discussion and Conclusion:

This study shows that in an unselected population mixing diabetic and non-diabetic patients, "SNS" is a robust technique to avoid impairing (deep) venous return at the level of the legs (0%), while maintaining a higher spatial resolution of the distal arteries. The image quality of the vessels at the two first stations is also improved with a modification of the acquisition order in the second pass of SNS that reduces blurring artifacts compared to prior observations. The time reduction to reach the tibio-fibular area leads to improved visualization of the trifurcation vessels (higher CNR). Further improvements in the quality of MRA might be achieved using high-density coil elements and parallel imaging technique in combination with "SNS".

References:

1. Foo TKF, et al. Radiology 2001; 219:835-41.
2. Maki J.H. et al. ISMRM 2004
3. Hervo P. et al. ISMRM 2003
4. Aksit P, et al. ISMRM 2002