Subclavian Artery Artifact in 3D MRA: Optimization of Gadolinium Injection Schemes

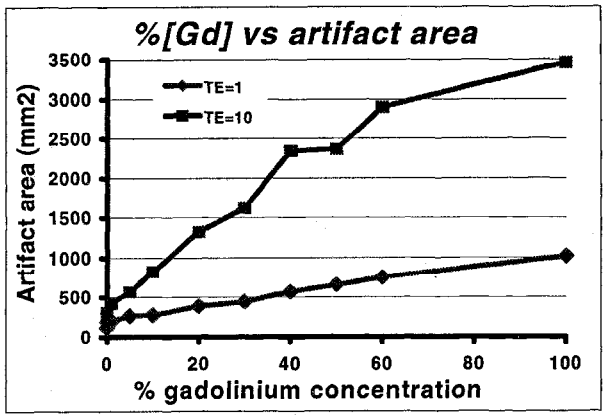
Mohammed Neimatallah, Thomas L. Chenevert, Ruth J. Carlos, Frank Londy, Qian Dong, Martin R. Prince.
Department of Radiology, University of Michigan, Ann Arbor, Michigan, USA

Purpose:
Although current ultra-fast sequences used for 3D angiography offer short echo times, high gadolinium concentrations in the vessel often result in signal loss due to T2* effects. This is particularly undesirable in the subclavian vein, when susceptibility artifacts from high gadolinium concentration also compromises visualization of the adjacent subclavian artery as well as other nearby great arch vessels. The purpose of this study is to design an injection protocol that allows imaging the artery without susceptibility artifacts.

Methods and Materials:

The optimization of the infusion protocol was carried out in both a phantom study and clinical study. All measurements we performed on a 1.5 T MR system (Horizon, GE Medical Systems, Milwaukee).

Phantom Study:
To assess the effect of gadolinium concentration and echo time on the amount of signal loss, an agar phantom was used containing 8 mm tubes with gadolinium doped gel ranging from zero percent (water) to 100 % (undiluted contrast agent). These samples were scanned at fixed TR (15msec) and variable TE (1,2,3,5 &10 msec) using a 3D spoiled gradient echo (GRE) sequence.



Patient Study:
Twenty consecutive patients undergoing thoracic 3D-Gd-MRA were randomly assigned to either one of the following infusion protocols: 100% contrast agent, 33% 25% and 20%. In all patients, the same 3D GRE sequence as in the phantom was used with the shortest TE possible. Artifacts of the subclavian artery and vein were assessed by three independent readers as either absent, mildly degrading image quality, severely degrading.

Results:
There is an increase in the artifact area around the vessel as the TE increased particularly for the high gadolinium concentration tubes. There was significant drop in the artifact area at a low gadolinium concentration (0.1 to 5%), however this dilution is not practical since the large volume required would result in an unrealistic injection rate. A compromise dilution around 20-30% was found to decrease the artifact when operating with short echo time ~1.1msec and could still be injected via a peripheral IV (4 ml/sec). A 16-18-gauge angiocatheter was required for hand injection of diluted gadolinium (3-4 cc/sec). At 20-30% dilution visualization of the subclavian artery free of susceptibility artifact was achieved.

Conclusion:
Dilution of gadolinium between 20 to 30% with shortest possible echo time ~1msec is practical and effective method to significantly decrease the artifact at the subclavian artery produced by the concentrated gadolinium in the subclavian or innominate veins.

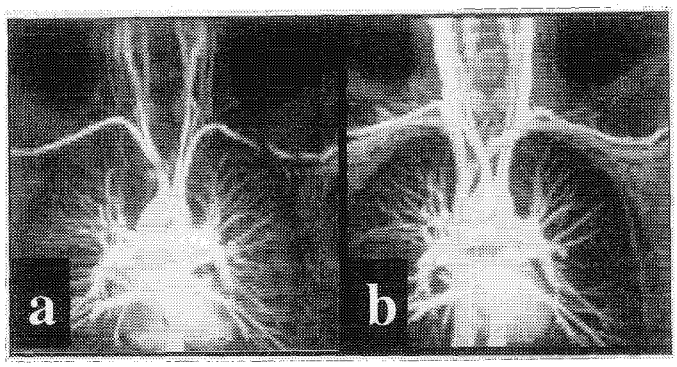


Fig 1: 100% Gadolinium arterial phase (a) shows T2 artifact obliterating the left subclavian vein and portions of the left subclavian artery. Equilibrium phase (b) shows true appearance of these vessels.*

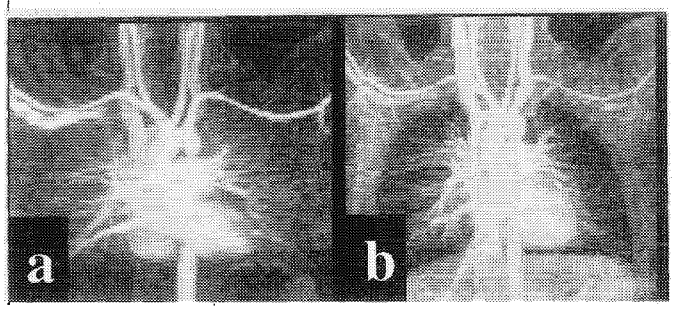


Fig 2: 20% gadolinium arterial phase (a) demonstrates reduced T2 effect with the right subclavian artery unaffected by minimal artifact within the right subclavian vein. Equilibrium phase (b).*