Assessment of central venous occlusion by injection of dilute contrast material into the upper extremities: "Direct" 3D MR Venography

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Introduction:

MR venograms can be acquired using time-of-flight and phase-contrast techniques. However, scan times are long and images are prone to artefact. Within the thorax, best image quality is acquired with breath-holding, however, the multiple breath-holds required make the technique unsuitable for many patients with suspected central venous occlusion.

Contrast-enhanced MRVenography:

After contrast agent is injected images of the venous system can be acquired using a long scan delay time. In clinical practice this usually means performing a second acquisition after the "arterial" phase has been performed. This technique has several disadvantages including the need for a substantial amount of post-processing to eliminate the effect of overlapping veins, difficulty in timing the bolus for "peak" venous enhancement and reduced signal-to-noise ratios within the veins due to tissue extraction of gadolinium chelate. Nonetheless, the technique has proven extremely robust in clinical practice. We refer to this approach as "indirect" MR venography – "indirect" as images are acquired during the venous phase after contrast has passed through the arterial and parenchymal circulations.

***"Direct"* MRVenography**

This approach exploits direct injection of contrast material into an upper limb extremity. Undiluted contrast agent injected into an upper limb extremity is either not visualized at all or causes severe artefactual signal drop-off within the subclavian artery due to it's proximity to the subclavian vein. This is due to marked T2* shortening of the highly concentrated gadolinium within the subclavian vein. Therefore, in order to generate diagnostic MR venograms on a "first-pass" the contrast agent must be substantialy diluted in order to overcome this T2* effect.

Materials and methods

Patients

16 patients with suspected central venous occlusion underwent 3D MRV, 5 patients also had dynamic 2D MRV.

Sequence parameters

All images were acquired at 1.5T.

3D MRV: TR/TE/(5msec/1.6msec/40deg. 512 x 192, 25 x 4mmslices interpolated to 50 x 2mm. Asymmetric FOV 400-450x320-450.

2D MRV: 100mm single slice, 512 x 192, FOV 400-450mm, images acquired dynamically during breath-holding with temporal resolution = 1sec.

Injection protocol

3D scan: Dilute contrast agent (3cc Gadolinium chelate in 50cc saline) was injected at a rate of 1.5cc/sec for a total dose of 30-50cc.

Bolus timing

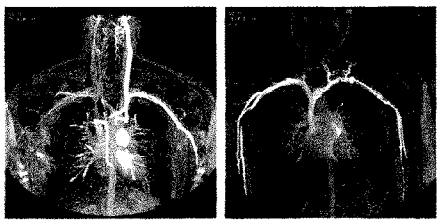
3D scan: Either fluoroscopic triggering with a centric phase order or an empiric scan delay time of 5seconds with a linear k-space profile order was used.

2D scan: No timing was necessary.

Results

Diagnostic images were obtained in 30 of 32 limbs (93%), there was failure to cannulate an upper limb in each of 2 patients. 6 patients had normal studies. There were 4 occlusions of the superior vena cava, and three brachiocephalic veins occlusions. 7 stenoses of the central veins were identified. MRV has 100% accuracy for diagnosis of central venous occlusion compared to correlative studies (CT, sonography and X-ray venography).

3D MRV – 2 patients



2D MRV

Discussion:

Injection of dilute contrast agent into an upper limb vein eliminates T2* shortening and allows acquisition of high quality venograms. The lower extremity veins can also be evaluated with this technique. Advantages include rapid acquisition (either 2D or 3D), no need for post-processing to eliminate arteries, and low cost due to the small dose of contrast agent injected into each arm.

References

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