High Resolution Peripheral CE-MRA featuring Continuous Table Movement (TimCT) and k-Space Segmentation: Initial Results

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Introduction

In the past few years multi-station peripheral contrast enhanced magnetic resonance angiography (CE-MRA) has widely been established as a clinical routine application. Fast gradient systems, automatic table translation in combination with the Tim (Total imaging matrix) surface coil technology facilitate bolus chase MRA from the level of the renal arteries down to the pedal vessels with high image quality and little to none venous enhancement. Most recently data acquisition and reconstruction during continuous table movement (TimCT) was introduced which pushes the limits of peripheral MRA (1). The method enables the acquisition of seamless large FOV data in surface coil image quality with a significantly streamlined workflow. In the current work, continuously moving table data acquisition was extended to k-space segmentation such that the central region of k-space is acquired during the first-pass and the peripheral region was acquired during the late phase of the contrast agent. With this method seamless peripheral CE-MRA with increased resolution was successfully performed on 5 patients with peripheral arterial occlusive disease.

Methods

To avoid venous overlay the total acquisition time of contrast enhanced MRA is conventionally restricted to the arterial time window which in peripheral MRA is typically less than 60 seconds. Segmentation of k-space (2, 3) permits to increase the total acquisition time and thus, the spatial resolution while the venous signal is efficiently suppressed. In the current work, this method was implemented for continuously moving table MRA for the first time. Therefore, the image acquisition and reconstruction method of Kruger et al. (4) was extended to acquire the central region of k-space and the k-space periphery in two independent runs.

5 patients with known peripheral arterial disease underwent a peripheral CE-MRA with continuous table movement and k-space segmentation: FLASH, TR/TE 3.19/1.24 ms, FOVtotal 362x1300 mm, matrix 348x1250, 96 slices, slice thickness 1.2 mm, partial Fourier. The radius in k-space defining the central region was selected such that the acquisition time of the first run was 52 s. The acquisition time of the second run was 118 s, which resulted in a total acquisition time of 2:50 s for the fully sampled 3D dataset. Gadubotrol (BayerSchering, Leverkusen, Germany) was administered at a contrast dose of 0.2 mmol per kg of body weight.

Results and Discussion

Peripheral CE-MRA with continuous table movement and k-space segmentation was successful in all 5 patients. Mild venous enhancement of the first pass of contrast was discovered in 3 of the 5 cases which, however, did not compromise image reading. Venous signal of the late phase of the contrast agent could not be detected (Fig. 1). Although parallel imaging, which could be used to further increase the spatial resolution, is fully compatible with the presented method, parallel imaging was not used in this initial study due to memory restrictions of the early prototype.

Conclusion

Segmentation of k-space to increase spatial resolution but to avoid venous overlay optimally integrates in the concept of continuously moving table MRA. The initial results presented in the current work are more than promising. In combination with parallel imaging the presented method will be a key feature for sub-millimeter large FOV CE-MRA.

Fig. 1: Peripheral CE-MRA with a total acquistion time of 2:50 min. Venous signal was largely suppressed by k-space segmentation.

References

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