3D CE-MRA of the Peripheral Arteries Featuring Surface Coil Coverage and Data Acquisition During Continuous Table Movement (TimCT)

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Introduction:

The development of multi-station MR angiography (MRA) techniques featuring table motion allowed for the stepwise extension of the conventional field-of-view (FOV) within a single MRA examination [1]. Although various multi-station approaches have shown to be effective and accurate [2], these protocols have inherent limitations: repositioning of the table between discrete stations reduces the scan time efficiency due to interruption of data acquisition during this process. Additionally, gradient non-linearities at the edges of individual FOVs might lead to artifacts between successive stations. Recently, continuous moving table techniques have been developed in order to improve data acquisition efficiency and to provide the physician with seamless images of the extended FOV [3], [4]. The purpose of the present study was to evaluate a novel MRA technique that features continuous moving table acquisition and whole-body surface receive coil coverage (TimCT). The continuously moving table method was compared with a conventional multi-station protocol with regards to its clinical routine workflow and image quality achieved.

Methods:

Ten patients with clinically documented occlusive arterial disease of the peripheral vasculature were examined with both techniques: 1) TimCT angiography and 2) a multi-station angiography protocol on a Siemens Avanto 1.5T system (Siemens Medical Solutions, Germany), which provides 32 receiver channels and a matrix of phased-array surface coils (Tim technology, Siemens). For signal reception a dedicated peripheral vasculature coil, two adjacent body phased-array coils, and a spine array coil (connecting to 16 of 32 receiver channels) were used, covering the peripheral vessel system from the renal down to the pedal arteries.

The TimCT protocol used consisted of 5 steps: 1.) a FastView (3D gradient echo sequence) was applied, which automatically reformatted from transversal slices into coronal and sagittal slices of the volume, followed by 2.) the TestBolus technique for contrast bolus timing and 3.) a VesselScout, displaying the peripheral arteries over the whole extended FOV as shown in figure 1a. Subsequently, a 3D FLASH sequence with TR/TE 2.44 ms/0.87 ms, FOV 400 mmx1300 mm, flip 25°, matrix 320x320 and a slab of 104 mm was used for 4.) the native pre-contrast as well as for 5.) the post-contrast injection measurement. Contrast agent (0.2 mmol/kg GD-BOPTA) was injected with a biphasic injection scheme. Parallel imaging with GRAPPA [5] (acceleration factor of 2, 24 reference lines) allowed for an acquired isotropic voxel size of 1.3 mm^3 within a total acquisition time of 77 sec.

Conventional three-station 3D peripheral MRA served as standard of reference and was conducted within 3 days. Scanning parameters for the conventional protocol were individually adapted for each station (pelvis/upper legs/lower legs): 3D FLASH: TR 3.0/3.0/3.12 ms, TE 0.97/0.97/1.04 ms, FOV 400x500/400x500/400x500 mm^2, flip 25°, matrix 345x384/345x384/410x520 and TA 15/15/20s.

Prior to data acquisition, a venous compression technique [6] was applied by placing two blood pressure cuffs at the mid-femoral level of both legs in order to avoid venous signal overlay. The cuffs remained inflated to 60mm Hg until the end of the exam.

Image quality was assessed on a segment per segment basis on coronal source images for both protocols by two radiologists in consent using a five point scale (from 1 = uninterpretable to 5 = very good).

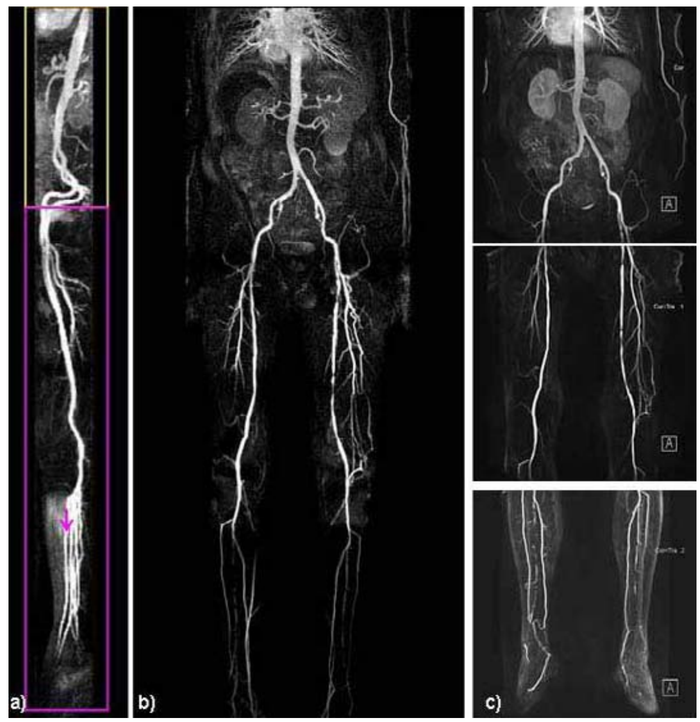

Fig. 1: The VesselScout from TimCT assists in planning the extended FOV over the region of interest (a). Coronal MIPS of (b) continuously acquired 3D peripheral MRA were compared to (c) conventional three-station 3D peripheral MRA in a patient with occlusive arterial disease. Note the overlapping FOVs in (a) while the TimCT acquisition provides one large seamless FOV.

Results:

Compared to images acquired with the standard peripheral MRA imaging protocol, continuously acquired data sets showed excellent correlation in all patients. Assessment of image quality revealed identical values for the conventional multi-station protocol compared to those data collected with the TimCT technique. This might also be accounted to the fact that “on-the-fly” active receiver coil switching has been available for both techniques providing signal reception from only those coils that are in the isocenter during data acquisition. Image interpretation and vessel assessment on TimCT images was facilitated due to the lack of discontinuity artifacts. However, due to higher spatial resolution of the two lower stations using the standard protocol, small intravascular arterial vessels appeared slightly crisper. The time for data reconstruction was comparable for both protocols (2 min). From a users point of view, the workflow of the TimCT protocol was facilitated since planning of the 3D MRA data set is performed on only one data set (VesselScout) while three individual 3D image slabs have to be positioned and oriented in the conventional multi-station protocol.

Conclusion:

The robustness of the technique, the image quality achieved as well as the improved operability compared to conventional 3D multi-station peripheral MRA justifies further evaluation of the TimCT continuously moving table technology in clinical routine examinations.

References:

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