Time-resolved three dimensional contrast-enhanced MR imaging of the hand.

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Introduction: Contrast enhanced MR imaging of the hand has been proposed as a noninvasive modality for the evaluation of the vascular anatomy and the vascularity of the soft tissue. Vessels in the hands are more thin and complex than those in the body and lower extremities. Therefore the imaging technique with high spatial resolution is necessary for depicting and recognizing vessels in the hands. However such a technique requires the relatively long acquisition time, resulting in acquiring imaging at limited phases. And an interval between the injection of the contrast agent and arrival at the target region may vary with patients. Thus the monitoring of the contrast arrival is important to obtain the proper image quality of contrast MR angiography. But it is difficult to depict the distal vasculature accurately all the time with using techniques such as a test bolus and fluoroscopic triggering technique. Time-resolved methods, which have been developed using enhanced gradient systems for fast imaging and applied to MR angiography in the neck, chest, abdomen and lower extremity, can collect sequentially three-dimensional data sets with high spatial resolution and without using the monitoring and may be useful in the hand. Thus, the purpose of the current study was to evaluate the usefulness of a time-resolved contrast-enhanced three-dimensional MR angiography with the three-dimensional Time-Resolved Imaging of Contrast KineticS (TRICKS) pulse sequence for vessels and the vascularities of the soft tissue anomalies in the hand.

Materials and Methods: Twenty-six patients (mean age 44.9 years; range 8-70 years) underwent MR imaging for the evaluation of lesions in the hand from April 2005 to September 2005. Clinical indications included masses (n=13), inflammatory lesions (n=8) and bone necrosis (n=5). MR imaging was performed on a 1.5-T system using dedicated surface coils (wrist coil, head coil and knee coil). The hand was wrapped in the coil and fixed with belts and sponges to reduce motion artifacts. After the mask acquisitions, gadolinium contrast material (0.2 mmol/kg body weight) was injected at a rate of 3.0 mL/second, flushed with a 15 mL saline, using an automatic infusion system via a 22-gauge catheter placed in the antebrachium vein of the contralateral arm. With 5-10 seconds interscan delay, time-resolved three-dimensional MR angiographic images were acquired sequentially. TRICKS imaging was performed with the following parameters: TR of 3.3-6.9 msec, TE of 1.0-1.9 msec, flip angle of 30 degrees, matrix size of 256x192, effective slice thickness of 1.0-2.0 mm, zero fill interpolation to 0.5-1.0 mm, 11-22 phases, frame rate of 4.5-8.9 seconds, total acquisition time of about 2 minutes 20 seconds.

Image Analysis: Sequential contrast enhanced three-dimensional data sets were obtained and maximum intensity projections (MIP) were generated at the time of imaging. If necessary, these data sets were transferred to a workstation and post-processed using partial MIPs and multiplanar reformations. First, we estimated the phase on which we could differentiate arteries from veins. Second, arteries in the hands were divided into three groups: 1) superficial and deep palmar arch; 2) common digital artery; 3) proper digital artery. And proper digital arteries were classified into two segments (proximal and distal segment). For the assessment of vessel delineation, degree of visualizations of each artery or segment was ranked using a five-point scale (1, unrecognized – 5, sharp definition). Third, for the assessment of the vascularities of the soft tissue, the site or positions of the enhanced lesions recognized on TRICKS images were compared with those on fat-suppressed T1-weighted postcontrast enhanced two-dimensional gradient-echo images as a standard. And we assessed the enhancement pattern of the soft tissue visually on TRICKS images.

Result: The large amounts of data (average 920 slices; range 648-1440 slices) including mask images were generated in one TRICKS study. At all twenty-six examinations, images provided information of arteries. Deep and superficial palmar arches were visualized well in thirty of thirty-two arteries (Table 1) (Figure 1). Common digital arteries were also visualized well in forty of forty-four arteries (Table 2) (Figure 1). Proper digital arteries were recognized to some extent (Figure 2) but it was difficult to differ these arteries from dorsal and palmar veins due to motion artifacts in three cases (Table 3). On TRICKS images we recognized all enhanced lesions in twenty cases. The lesions included a glomus tumor (n=1), an enchondroma (n=2), a giant cell tumor of tendon sheath (n=1), a squamous cell carcinoma of skin (n=1), a synovitis (n=5), a tenosynovits (n=3), an old thrombus (n=1), a non-specific inflammatory lesion (n=6). We recognized the semiquantitative perfusion of the soft tissue anomalies such as a glomus tumor (Figure 2) with very early and well enhancement and a synovitis with gradually enhancement.

Discussion: TRICKS images showed vasculature in the hands in all cases. Success rate of visualization of arteries for MR angiography was 100 %. TRICKS images provide vascular anatomy as well as perfusion of soft tissue lesions in semiquantitative fashion. This technique can be assessed for the evaluations of the vasculature in the hands and characterization of the soft tissue lesions when existed. Because of high temporal resolution and spatial resolution, any direction of reconstructed images and partial MIP of the image data clearly separated arteries and veins.

Conclusion: In summary, TRICKS MR angiography of the hand can provide the vessel anatomy and the semiquantitative perfusion of soft tissues without consideration of time for triggering imaging after contrast injection.

Figure 1. A MIP image at 2nd phase on TRICKS MRA in a 48-years-old man with the hand edema, depicting superficial and deep palmar arch and common digital arteries.

Figure 2. Glomus tumor of the second finger in a 39-years-old woman. A MIP image at 4th phase shows that early enhancement of the tumor (arrow). Proper digital arteries were visualized well in this case.

Figure 1

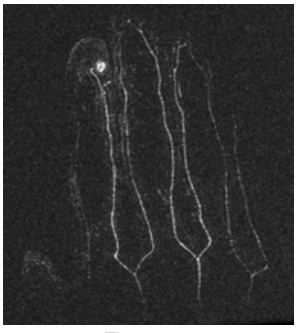

Figure 2

Scores for visualization of arteries

	superficial palmar arch		deep palmar arch	
score	wrist	whole hand	wrist	finger
1	1	1	0	0
2	0	0	0	0
3	2	0	2	1
4	0	4	2	4
5	3	4	4	4

Table1

	proper digital artery (proximal)		proper digital artery (distal)	
score	whole hand	finger	whole hand	finger
1	8	0	24	0
2	9	1	6	3
3	16	2	23	0
4	19	4	1	3
5	8	20	0	20

Table 2

	common digital artery		
score	wrist	whole hand	finger
1	0	3	0
2	0	1	0
3	0	6	0
4	2	2	0
5	6	18	6

Table 3