3D-BLACK-BLOOD 3T-MRI FOR THE DIAGNOSIS OF THORACIC LARGE VESSEL VASCULITIS: A FEASIBILITY STUDY

Karla Maria Treitl[1], Stefan Maurus[1], Hendrik Kooijmann-Kurfuerst[2], Eva Coppenrath[1], Nora N. Kammer[1], Marcus Treitl[1], Maximilian Reiser[1], and Tobias Saam[1]
[1]Institute for clinical radiology, LMU Munich, Munich, Bavaria, Germany, [2]Philips Healthcare, Philips GmbH, Hamburg, Hamburg, Germany

Target Audience: Radiologists.

Purpose: The diagnosis of large vessel vasculitis (LVV) is challenging, because the clinical symptoms and the biochemical tests of this heterogeneous group of inflammatory diseases are unspecific[1]. FDG-PET/CT is well established to diagnose LVV[2], but the repetitive radiation exposure limits its application as a screening or monitoring tool. Contrast-enhanced (CE) fat suppressed 2D black-blood (BB) magnetic resonance imaging (MRI) is a valid and reproducible imaging technique to noninvasively detect concentric wall thickening (CWT) and contrast media uptake as morphological correlates for segmental inflammation of arteries[3], but conventional 2D-BB sequences are time consuming and limited in their coverage. The presented novel isotropic-high-resolution 3D T1w TSE sequence (VISTA Volumetric ISotropic TSE Acquisition) provides excellent flow suppression by variable-flip-angle refocusing pulses that lead to a longer echo train length and shorter acquisition times[4]. The purpose of this study was to evaluate the feasibility of the commercially not available 3D T1w VISTA sequence for the diagnosis of thoracic LVV.

Methods: 23 patients (13-80 yrs.) with suspected LVV and 25 controls (13-81 yrs.) who underwent cardiac or oncologic MRI, were imaged at 3.0T using fat suppressed T1w 3D VISTA with an interpolated spatial resolution of 0.6 x 0.6 x 1.0 mm^3 using a navigator and peripheral pulse unit triggering pre- and post-contrast (voxel size of 1.2 x 1.3 x 1.0 mm^3, scan time: 3:17 min., effective scan time 5-6 min.). Depending on the body size, the 3D VISTA stack covered the lower neck and the chest, extending from the shoulders to the diaphragm. Aortic arch, ascending and descending aorta, left and right subclavian and pulmonary arteries were evaluated by two readers in consensus decision for image quality (IQ), flow artifact intensity (FAI), CWT, CE and diagnostic confidence level (DCL) on a four-point scale (Tab. 1).

Table 1: Imaging Quality Scoring

	CE/ CWT/ FAI
3	None CE/CWT/FAI visible
2	Minimal CE/CWT; minor FAI
1	Moderate CE/CWT; major FAI
0	Substantial CE/CWT; dominating FAI
	IQ/ DCL
4	Excellent: exact diagnosis possible
3	Good: definite diagnosis possible
2	Adequate: evaluation of major findings possible
1	Insufficient: definite diagnosis impossible

Results: IQ was good (3.11±0.86) in 45 out of 48 exams, respectively 230 out of 288 arterial segments (80.0%). The overall and the separate IQ of every vessel segment were comparable between the vasculitis and the control group (3.18±0.73 vs. 3.30±0.67; P=0.201). Overall 216 out of 288 segments showed no or minor FA (75.0%; mean: 0.89±0.82), comparing both groups, the FAI of the vasculitis group was significantly higher (1.03±0.93 vs. 0.77±0.70; P<0.040). FAI was highest in the pulmonal arteries (1.73±0.74) and lowest in descending aorta (0.58±0.77). CE and CWT were significantly more common in arterial segments in the vasculitis group (52.9% vs. 3.3%; P<0.001 and 58.7% vs. 3.3%; P<0.001). CE was strongly correlated with CWT, (Spearman´s R=0.880; P<0.001). The DCL was comparable for both groups (CE: 3.37±0.62 vs. 3.47±0.64; P=0.128; CWT: 3.38±0.70 vs. 3.49±0.64; P=0.190). DCL was highest in the descending thoracic aorta (CE: 3.65±0.57 vs. 3.76±0.44; CWT: 3.61±0.58 vs. 3.76±0.44) and lowest in the pulmonary arteries (CE: 3.19±0.85 vs. 3.12±0.78; CWT: 2.94±0.85 vs. 3.04±0.74.

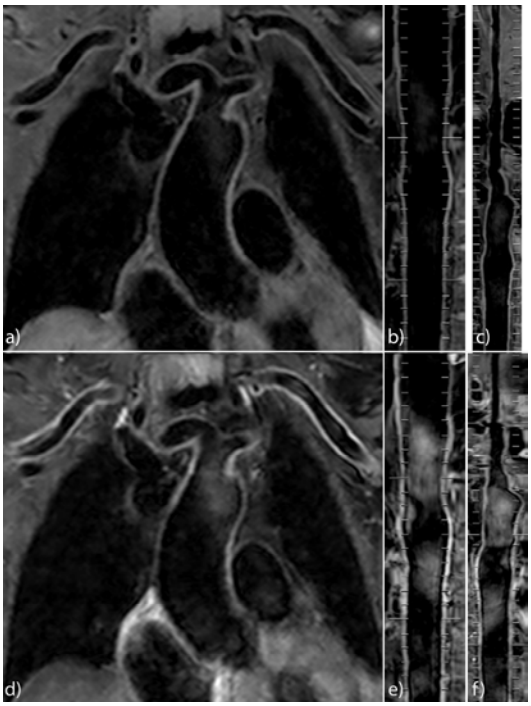

Fig. 1: Coronal pre- and post contrast (a, d) VISTA-MRI of the thorax of a 77-yr-old with giant-cell-arteritis and inflammatory activity of the thoracic aorta and both subclavian arteries; orthogonal reconstruction of the aorta pre- and post contrast (b, e); orthogonal reconstruction of the aorta and the left subclavian artery (c) as well as the common and internal carotid artery (f).

Discussion: VISTA-MRI pre- and post-contrast detected segmental CWT and CE in 23 patients with suspicion for vasculitis (100.0%), which was confirmed clinically in all patients. Only 5 segments of the control group (3.3%) in 4 distinct patients showed CWT and CE and orthogonal reconstruction of these segments revealed that CWR war rather semicircular and CE did not extend into the surrounding tissue, suggesting the presence of activated atherosclerotic plaques. CE and CWT was highly correlated, suggesting that both signs usually appear coincidentally in patients with LVV. Only 7 arterial segments showed CWT without CE, which might be explained by a more chronic stage of LVV, in which acute inflammation is decayed, but has caused morphological changes[1]. The FAI was more frequent in the vasculitis group and caused by the higher degree of luminal narrowing, but, this did not affect the DCL or the IQ. The best IQ, the least FAI and the best DCL were achieved in the descending thoracic aorta, because this is the most immobile vessel with the largest diameter and the straightest course. In contrast to that, the worst IQ, the most FAI and the lowest DCL were achieved in the pulmonary arteries, that are most affected by pulsation and breathing artifacts. BB-MRI is established for the non-invasive characterization of arteriosclerotic plaques and inflammatory changes in the temporal superficial artery[3] and in intracranial arteries[5]. Although FDG-PET/CT is currently the gold standard for the diagnosis and the monitoring of LVV, VISTA-MRI offers the advantages of a simultaneous assessment of CE and CWT, a better differentiation between atherosclerotic and inflammatory changes and is not associated with radiation exposure. Limitations of this study are the small study cohort, the missing comparison with clinical symptoms or other diagnostic imaging modalities and the lack of follow-up examinations.

Conclusion: Free breathing navigated BB-MRI is feasible in less than 12 minutes scan time and allows diagnosing thoracic vasculitis. Future studies are necessary to evaluate VISTA-MRI for monitoring of anti-inflammatory therapies and to perform a comparison with PET/CT and ultrasound.

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