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ORIGINAL ARTICLE / *Vascular imaging*

Unenhanced respiratory-navigated NATIVE® TrueFISP magnetic resonance angiography in the evaluation of renal arteries: Comparison with contrast-enhanced magnetic resonance angiography

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KEYWORDS
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Abstract
Purpose: To compare unenhanced three-dimensional (3D) NATIVE® true fast imaging with steady-state precession (TrueFISP) magnetic resonance (MR) angiography with the more conventional MR angiography technique obtained after intravenous administration of a gadolinium chelate in the evaluation of renal arteries and their branches in patients with suspected renal artery stenosis.
Materials and methods: A total of 39 patients (25 men, 14 women) with a mean age of 51.4 ± 17.5 years (SD) (range: 10—82 years) were included in the study. All patients with suspected renal artery stenosis underwent unenhanced 3D NATIVE® TrueFISP MR angiography and contrast-enhanced MR angiography. The two MR angiography methods were compared by two independent readers for image quality using a four-point scale, diagnostic performance and grading of renal artery stenosis on a total of 78 renal arteries.

Abbreviations: RAS, renal artery stenosis; CE-MRA, contrast-enhanced magnetic resonance angiography; TOF, time of flight; PC, phase contrast; SSFP, steady-state free precession; 3D, three dimensional; TrueFISP, true fast imaging with steady-state precession; TI, time inversion; VR, volume rendering; MIP, maximum-intensity projection; FOV, field of view.

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Results: For both readers image quality of unenhanced 3D NATIVE® TrueFISP MR angiography (3.12 to 3.63) was greater than that of contrast-enhanced MR angiography (1.94 to 2.71) for renal artery ostium-trunk and the left renal artery segmental branches. The sensitivity of 3D NATIVE® TrueFISP MR angiography for the diagnosis of renal artery stenosis was 100% for both readers for the right renal artery and 66% and 80% for the left renal artery for reader 1 and reader 2, respectively. Agreement between 3D NATIVE® TrueFISP MR angiography and CE-MR angiography was 95% (74/78) for reader 1 and 92% (72/78) for reader 2.
Conclusion: Unenhanced NATIVE® TrueFISP magnetic resonance angiography can play an additional role in the evaluation of renal arteries in patients with hypertension, especially in subjects at risk of nephrogenic systemic fibrosis.

Renovascular disease is the major cause of secondary hypertension. Computed tomography (CT) angiography has demonstrated high degrees of sensitivity and specificity in the evaluation of renal artery atherosclerotic disease. However CT-angiography is a radiating technique and needs intravenous administration of iodinated contrast material that may affect renal function. Digital subtraction angiography (DSA) is the reference imaging method for the evaluation of renal artery. However, DSA is an invasive technique [1]. Magnetic resonance angiography (MRA) is an important imaging method for evaluating renal artery stenosis (RAS). Contrast-enhanced MRA (CE-MRA) is a technique that is widely used and recognized in evaluating RAS [2]. The use of gadolinium-based contrast agents for patients with advanced renal function impairment is considered to be associated with the development of nephrogenic systemic fibrosis. This is why it is of importance to develop unenhanced MRA techniques [3]. Conventional unenhanced MRA techniques, such as time of flight (TOF) and phase contrast (PC), are widely used for evaluating intra-cranial and carotid vascular structures and qualitative flow measurements. The use of conventional unenhanced MRA techniques in renal artery is limited because of a long acquisition time, signal loss in turbulent flow, and images are affected by motion artifacts [4]. The newly developed steady-state free precession (SSFP) techniques are able to create high quality renal artery MR images in shorter periods of time. Motion artifacts can be reduced by using electrocardiography triggering and respiratory navigation with these techniques [1]. The three-dimensional (3D) non-contrast angiography of the arteries and veins, true fast imaging with steady-state precession (NATIVE® TrueFISP, Siemens Healthcare, Erlangen, Germany), is a new balanced SSFP-based method, that uses a spatial selective inversion pulse applied on the imaging volume. This pulse suppresses static tissue signal and blood signal. But, non-inverted blood entering into imaging volume during the time inversion (TI) period is displayed as bright blood.

The aim of this study was to compare unenhanced 3D NATIVE® TrueFISP MRA with the more conventional MR angiography technique obtained after intravenous administration of a gadolinium chelate in the evaluation of renal arteries and their branches in patients with suspected RAS.

Materials and methods

Patients

The local ethical committee approved this study and written informed consent was obtained from all patients prior to enrollment. A total of 39 patients with a mean age of 51.4 ± 17.5 years (SD) (range: 10—82 years) were included in the study. There were 25 men and 14 women. All patients were suspected of having RAS. Blood pressure, heart beat rate, creatinine and glomerular filtration rate values of the patients were recorded. Patients were excluded from the study when estimated glomerular filtration rate less than 30 mL/min/1.73 m^2.

MR examination technique

All MR examinations were performed using a 1.5-T MR unit (Magnetom Avanto®, Siemens Healthcare, Erlangen, Germany). All the patients were first scanned by 3D NATIVE® TrueFISP MRA. The scanning was performed by using a combination of body matrix and spine array coil. Respiratory-gated navigation was used in 3D NATIVE® TrueFISP MRA in order to reduce motion artifacts. The respiratory-gated navigator was placed at the level of the hepatic dome. Two separate spatial selective inversion pulses were used in order to suppress the signal from background stationary tissues and venous blood on the imaging volume. The first inversion pulse was placed to cover the imaging field of view (FOV), while the second inversion pulse was placed inferior to the first inversion volume. Second inversion pulse helped suppress venous signal from the inferior vena cava. 3D NATIVE® TrueFISP MRA can be performed in a shorter time without using the second spatial selective inversion pulse. However, this would not suppress the inferior vena cava signal and cause difficulties in evaluating the right renal artery. Following the 3D NATIVE® TrueFISP sequence, all patients underwent a standard CE-MRA examination. 3D CE-MRA was performed after intravenous administration of a gadolinium chelate (gadodiamide, Omniscan®, Amersham Health or gadopentetate dimeglumine, Magnevist®, Bayer-Scherring) at a dose of 0.2 mmol/kg and a rate of 2.5 mL/s, using a bolus-tracking

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