Non Contrast 3D Volumetric Time-Resolved MRA combining Multiple Phase FAIR (CINEMA-FAIR)

M. Nakamura1, M. Yoneyama1, T. Okuaki1, T. Tabuchi1, A. Takemura2, M. Obara1, J. Ogura1, and S. Tsutsumi1

1Medical Satellite Yaesu Clinic, Chiyoda-ku, Tokyo, Japan, 2Philips Electronics Japan, Tokyo, Japan, Neurosurgery, Juntendo University Urayasu Hospital, Chiba, Japan

Introduction
Detailed information on anatomy and hemodynamics in cerebrovascular disorders such as AVM and Moyamoya disease is mandatory for defined diagnosis and treatment planning [1]. DSA may still be a gold standard for diagnostic modality but is otherwise invasive. Contrast-enhanced dynamic MR angiography (CE-dMRA) is a useful technique but poses a risk associated with contrast agent [2]. Currently most widely used non-contrast MRA techniques are TOF and PC. Also arterial spin labeling (ASL) technique has come to be applied to MRA and perfusion imaging in recent years [3, 4]. Those non-contrast techniques are, however, mostly limited to a single frame images. Recently we have proposed 3D volumetric non-contrast time-resolved MRA technique termed Contrast inherent inflow enhanced multi phase angiography combining multiple phases FAIR (CINEMA-FAIR). CINEMA was developed as a technique that enables diachronic observation of hemodynamics as in CE-dMRA and extensive 3D volume acquisition with the whole brain as a target. We present a preliminary study of CINEMA sequence and discuss its clinical relevance.

Methods
Theory and Pulse Sequence: CINEMA-FAIR technique combines ASL with 3D segmented T1 weighted gradient echo sequence (3D T1 TFE). FAIR preparation scheme with the Look-Locker sampling was used for spin tagging in this study (Fig 1) [5, 6]. Each measurement of the sequence was composed of two acquisitions with identical readout and different magnetization preparation schemes. Measurement was taken by two consecutive acquisitions preceded by contrast agent [2]. Currently most widely used non-contrast MRA techniques are TOF and PC. Also arterial spin labeling (ASL) technique has come to be applied to MRA and perfusion imaging in recent years [3, 4]. Those non-contrast techniques are, however, mostly limited to a single frame images. Recently we have proposed 3D volumetric non-contrast time-resolved MRA technique termed Contrast inherent inflow enhanced multi phase angiography combining multiple phases FAIR (CINEMA-FAIR). CINEMA was developed as a technique that enables diachronic observation of hemodynamics as in CE-dMRA and extensive 3D volume acquisition with the whole brain as a target. We present a preliminary study of CINEMA sequence and discuss its clinical relevance.

Introduction
Detailed information on anatomy and hemodynamics in cerebrovascular disorders such as AVM and Moyamoya disease is mandatory for defined diagnosis and treatment planning [1]. DSA may still be a gold standard for diagnostic modality but is otherwise invasive. Contrast-enhanced dynamic MR angiography (CE-dMRA) is a useful technique but poses a risk associated with contrast agent [2]. Currently most widely used non-contrast MRA techniques are TOF and PC. Also arterial spin labeling (ASL) technique has come to be applied to MRA and perfusion imaging in recent years [3, 4]. Those non-contrast techniques are, however, mostly limited to a single frame images. Recently we have proposed 3D volumetric non-contrast time-resolved MRA technique termed Contrast inherent inflow enhanced multi phase angiography combining multiple phases FAIR (CINEMA-FAIR). CINEMA was developed as a technique that enables diachronic observation of hemodynamics as in CE-dMRA and extensive 3D volume acquisition with the whole brain as a target. We present a preliminary study of CINEMA sequence and discuss its clinical relevance.

Methods
Theory and Pulse Sequence: CINEMA-FAIR technique combines ASL with 3D segmented T1 weighted gradient echo sequence (3D T1 TFE). FAIR preparation scheme with the Look-Locker sampling was used for spin tagging in this study (Fig 1) [5, 6]. Each measurement of the sequence was composed of two acquisitions with identical readout and different magnetization preparation schemes. Measurement was taken by two consecutive acquisitions preceded by contrast agent [2]. Currently most widely used non-contrast MRA techniques are TOF and PC. Also arterial spin labeling (ASL) technique has come to be applied to MRA and perfusion imaging in recent years [3, 4]. Those non-contrast techniques are, however, mostly limited to a single frame images. Recently we have proposed 3D volumetric non-contrast time-resolved MRA technique termed Contrast inherent inflow enhanced multi phase angiography combining multiple phases FAIR (CINEMA-FAIR). CINEMA was developed as a technique that enables diachronic observation of hemodynamics as in CE-dMRA and extensive 3D volume acquisition with the whole brain as a target. We present a preliminary study of CINEMA sequence and discuss its clinical relevance.

Results
Major intracranial blood vessels were extracted successfully in all volunteer studies. Longitudinal magnetization and signal intensity of CINEMA-FAIR images from volunteer studies were identical to the simulation result (Figure 2). CINEMA-FAIR could extract the blood flow in the whole brain at an interval of 100 ms and thus permitted us to observe vascular construction in full by preparing MIP images of axial, coronal, and sagittal acquisitions with 1 mm × 1 mm × 1 mm spatial resolution. In MIP images TOF and CINEMA sequence were performed on a Philips Achieva 3.0 Tesla scanner with Nova Dual gradients and software release 2.6 was used together with an 8 elements head coil. The alteration in longitudinal magnetization of stationary tissues and moving tissues (blood stream in this study) was converted into numbers by simulation. The signal strength of stationary tissues and blood stream were measured from images obtained from volunteer subjects and compared with the simulation models. The image quality of CINEMA-FAIR was compared with that of TOF MRA in terms of the depiction of the detailed anatomy.

Conclusion
This preliminary study demonstrated the usefulness of CINEMA-FAIR technique in evaluating the cerebral vasculature. High quality both in temporal and spatial resolutions was simultaneously achieved, obviating the need for contrast agent. Patients carrying cerebrovascular abnormalities such as AVM and Moyamoya disease are subjects of further investigations (Fig 4).

References