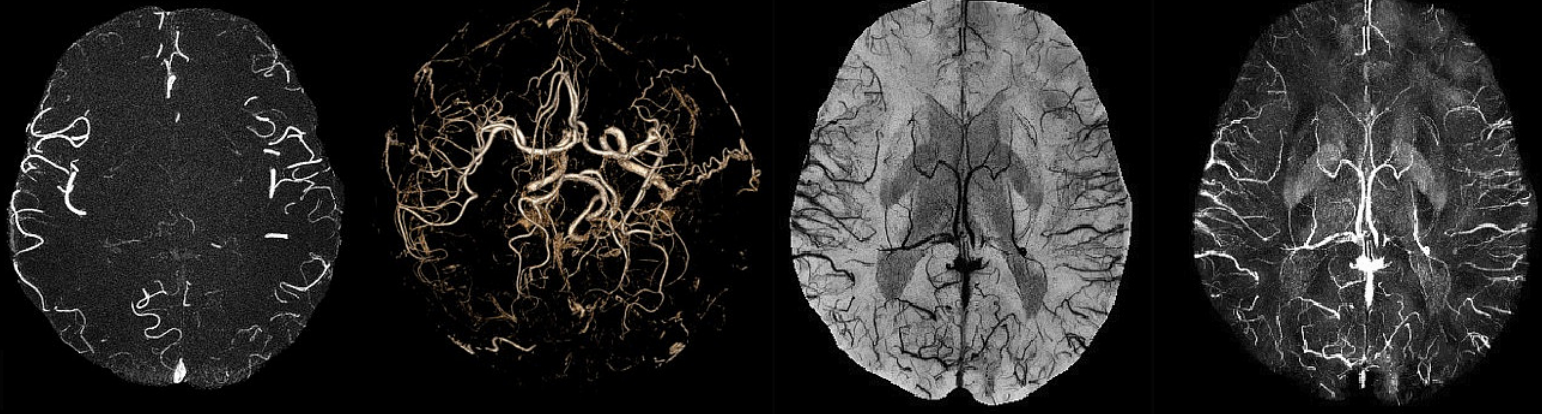# Magnetic Resonance Innovations

"Your partner in brain image analysis"

Magnetic Resonance Innovations, Inc. was founded in late 1994, by E. Mark Haacke, PhD.

Today, we are positioning ourselves to combine our patents, expert consulting knowledge and service experience to produce advanced MRI post-processing modules that quantitatively assess and extract key regions of interest, biomarkers and pathological landmarks for the research and diagnosis of neurological diseases.

We assist institutions with longitudinal research by providing quantifiable metrics for neurodegenerative diseases:
* Multiple Sclerosis
* Traumatic Brain Injury
* Parkinson's Disease
* Stroke
* Migraine
* Dementia
* Idiopathic Intracranial Hypertension
* Headache

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Data Processing & Technical Reporting Services

MR Innovations provides post-processing & data analysis for different MR sequences, including:

Susceptibility Weighted Imaging (SWI) & Quantitative Susceptibility Mapping (SWIM):
*Cerebral Microbleed Detection
*Medullary Vein Damage and Thrombus
*Venous Oxygen Saturation
*Gray Matter Iron Content
*Venography Projections

Phase Contrast Flow Quantification (PCFQ-MRI):
*Arterial, Venous, and Cerebrospinal Fluid Flow
*Normalized Cerebral Blood Flow
*Flow and Velocity Profiles through the Cardiac Cycle

Perfusion Weighted Imaging (PWI) / Arterial Spin Labeling (ASL):
*Cerebral Blood Flow / Blood Volume (CBF & CBV)
*Mean Transit Time (MTT)
*Lesion Comparison to normal appearing White / Gray Matter

Diffusion Tensor Imaging (DTI):
*Fractional Anisotropy (FA)
*White Matter Fiber Tracking / Tractography
*FA Assessment of Key White Matter Structures

Conventional Magnetic Resonance Imaging:
*Brain Volume
*Brain Segmentation
*Lesion Identification
*T1WI, T2WI, PD, T2 FLAIR, DWI

Functional Magnetic Resonance Imaging (fMRI):
*Resting State fMRI
*Task/Stimulus Based fMRI

Vascular Imaging:
*2D/3D Time of Flight
*3D Contrast Enhanced MRA/MRV
*3D Rotatable Projections
*Vessel tracking

EXPEDITED SHORT REPORT (ESR)
We provide a 24 hour turn-around for the expedited short report (ESR) which summarizes essential quantitative measurements and structural assessments.

FULL TECHNICAL REPORT (FTR)
Our full technical reports have a one week turn-around time and include a complete quantitative analysis of our comprehensive protocols, as well as a two page summary. We are constantly data mining these images and looking for important biomarkers for these neurological diseases.

PUBLISHING
Work with us and we will help you publish your research.

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STAGE Imaging

Strategically Acquired Gradient Echo (STAGE) can image the whole brain and its vasculature in 6 minutes.

Features:

* Co-registered T1W, PDW, T1 MAP, PD MAP, R2* MAP, SWI, MRA and SWIM with a resolution of 0.7mm x 1.4mm x 2.7mm and with 48 partitions.
  * B1: TE=7.5ms/18.5ms, FA=6 degress, 2 minutes
  * B2: TE=7.5ms/17.5ms, FA=24 degrees, 2 minutes
  * B3: TE=5ms (RP)/17.5ms (DP), FA=24 degrees, 2 minutes

* Add 3 more minutes to obtain a T2 weighted image and an ADC MAP.
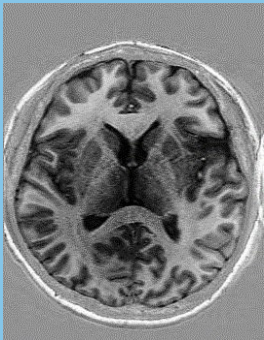* Allows for separation of arteries and veins.
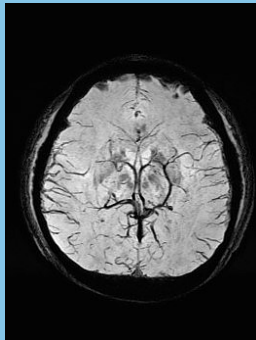* Data Processing done by SPIN software from MR Innovations.

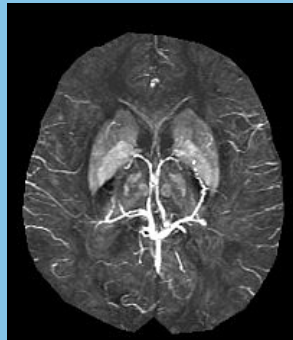## STAGE 2 Protocol

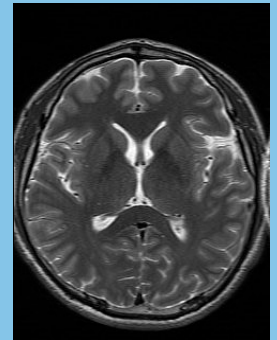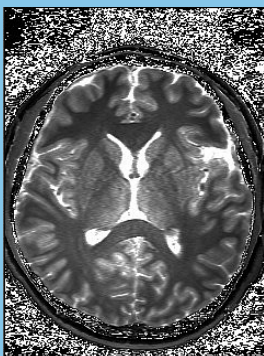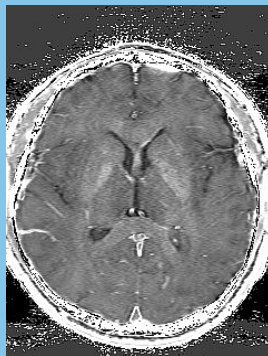*6 minutes total scan time:*   *Add 3 more minutes:*
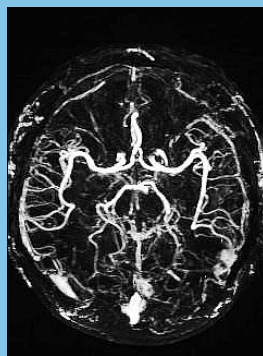
T1   SWI   SWIM   T2
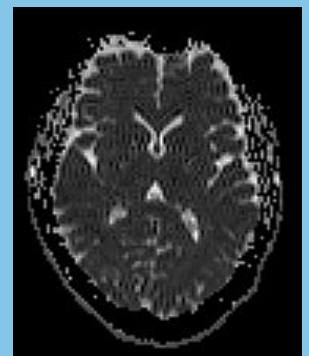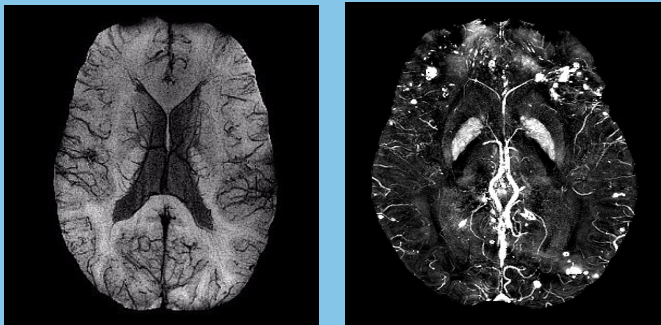

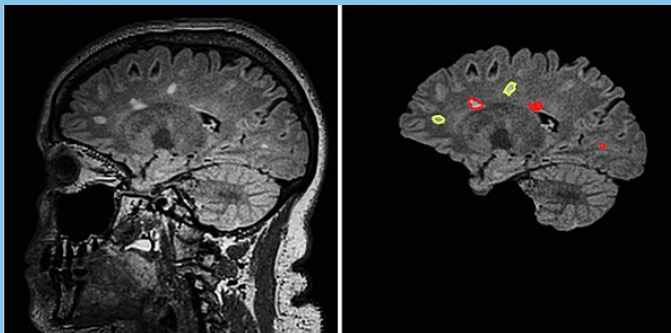T1 MAP   R2* MAP   MRA   ADC MAP

Our Products

SPIN is a user-friendly, fast and reliable medical image software package with most common basic image viewing tools and advanced quantitative MR post-processing tools. SPIN was created as the main platform for our advanced modules in order to provide the radiology community with a comprehensive solution for quantitative MRI analysis. It includes advanced quantification modules for blood flow, iron content, cerebral microbleeds, white matter hyperintensities and perfusion imaging.

Susceptibility Weighted Imaging (SWI) &
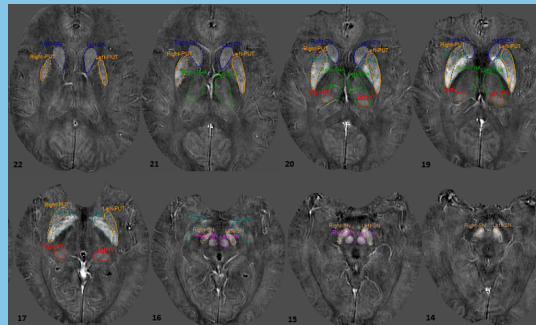*Quantitative Susceptibility Mapping (SWIM)*

Iron Quantification (IRON):
Advanced module to provide the means to quantify iron content in every part of the brain.

Cerebral Microbleed (CMB):
Detects CMBs and quantifies their number, volume and iron content.

White Matter Hyperintensity (WMH):
Offers new algorithms foDetects abnormal WM lesions with clinical applications in: longitudinally tracking disease progression or drug treatment efficacy

Perfusion Weighted Imaging (PWI):
Offers new algorithms for estimating perfusion to brain tissue such as double injection perfusion analysis for better arterial input function estimation.

Flow Quantification (FLOW):
Quantifies the speed of the blood in every pixel and makes it possible to measure the total flow into and out of the brain as a function of the cardiac cycle.

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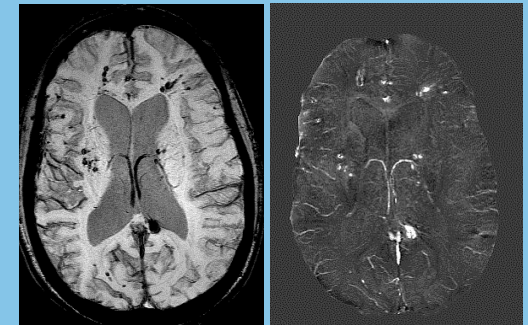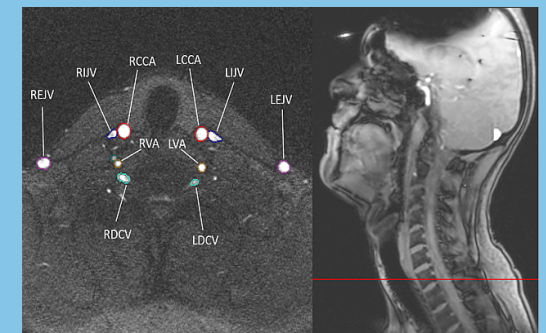440 East Ferry Street
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Susceptibility Weighted Imaging

SPIN SWI utilizes magnitude and phase information from a fully velocity compensated, three dimensional, rf spoiled gradient echo MRI scan to automatically generate **Susceptibility Weighted Imaging (SWI)** images. SPIN SWI can be run on data from any manufacturer's machine at field strengths of 1.0T, 1.5T, 3.0T & 7.0T.
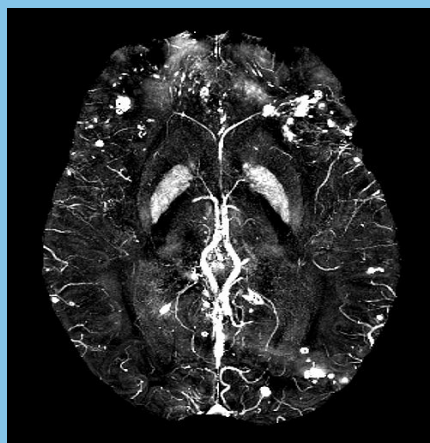

FEATURES:
* Patented technology
* Multiple Phase Filters Available
* mIP and MIP Capability
* Enhanced contrast, revealing venous blood, hemorrhage and iron deposits
* Better diagnosis and monitoring of disease in clinical and research settings

Susceptibility Weighted Imaging & Mapping

SPIN SWIM (Susceptibility Imaging and Mapping) is our advanced post-processing module for quantitative susceptibility mapping. SPIN SWIM utilizes high-resolution gradient echo MRI data and applies multiple processing steps including eddy current correction, brain extraction, phase unwrapping, background field removal and finally applies a propitiatory inverse filter to generate the susceptibility map. The maps created by SPIN SWIM can be used to evaluate microbleeds and iron content *in vivo*, to better understand its behavior in normal and disease states.

FEATURES:
* Less than 10 seconds processing time for a conventional single dataset (64-3D slices)
* Propriety algorithms to minimize phase-related artifacts
* Batch processing for large datasets
* Support data from multiple manufacturers
* Continuous improvements to the core algorithms

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IRON Quantification

SPIN IRON quantification module is based on the use of quantitative susceptibility maps (the intensity of which is given in parts per billion) which is representative of, and proportional to, the concentration of iron in the tissue (where 1μg of Fe/g wet tissue is roughly equal to 1.1 ppb in the SWIM images).

Based on one of our papers, we used a large cohort of 174 healthy subjects to establish a robust baseline of iron content in seven basal ganglia and midbrain structures as a function of age. Global analysis (3D whole-structural) and regional analysis (the pixel-wise high iron content region defined as susceptibility values higher than two standard deviations above the mean from the global analysis) were evaluated. As a result, the regional analysis has shown a much tighter linear age-related behavior in almost all structures. This novel method potentially allows the differentiation of normal from abnormal iron deposition providing physicians with another quantitative metric which may be useful in understanding the etiology and treatment requirements for different neurodegenerative diseases.

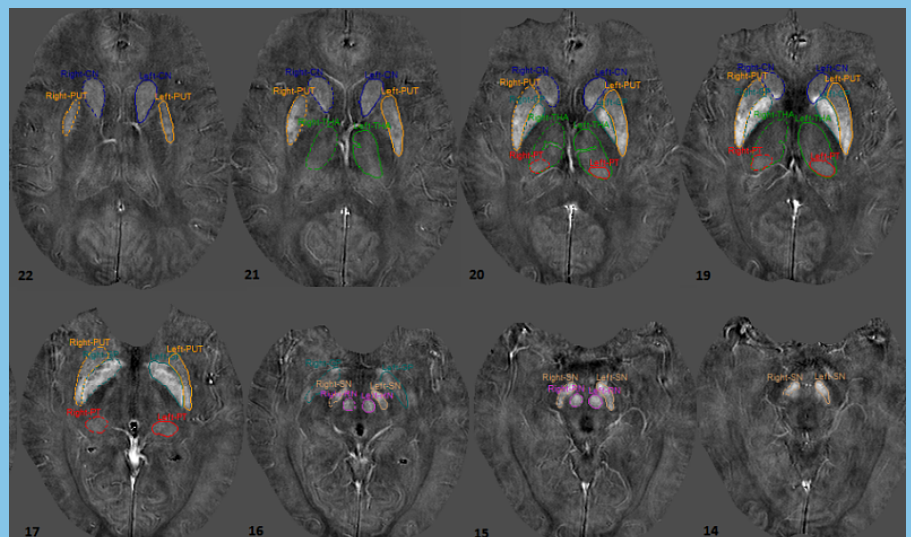## Features and Clinical Use

FEATURES:
* Fast, easy to use and reliable software
* Automatic labeling of 7 pairs of structures in the midbrain and basal ganglia
* Quantification of iron in each structure from either phase or SWIM data
* Supports single and multi-echo processing

CLINICAL USE:

* Multiple Sclerosis, Dementia, Parkinson's Disease, Huntington's Disease, Normal Aging & Cerebral Microbleed

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Detection and Quantification of Cerebral Microbleeds

Our **SPIN CMB (Cerebral Microbleed)** software automatically detects and quantifies the CMBs in the brain. With the advent of new susceptibility weighted imaging techniques, there has been a recent increase in research on CMBs that has shown them to be associated with many neurological diseases, including traumatic brain injury, stroke, dementia, hypertensive arteriosclerosis, and more. In the case of stroke treatment, it is critical to know if CMBs are present as the use of anti-platelet may or may not be advisable if evidence of previous bleeding is present. The number of CMBs, their timeline of development, and their locations may be used as a precursor for diagnosis of dementia and vascular disorders.

By helping to limit the interpreter bias in the detection of CMBs, this module may facilitate better treatment options. Further, by providing quantitative metrics, longitudinal information can be used in the clinical setting.
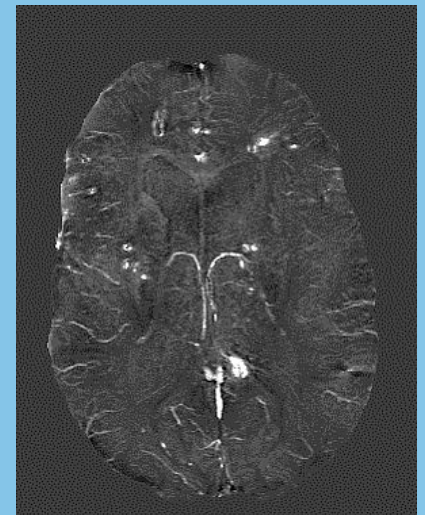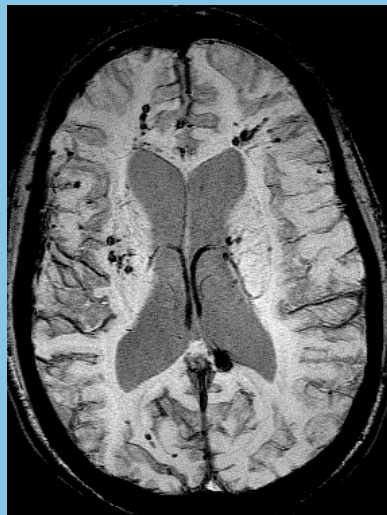
Features and Clinical Use

FEATURES:
* Automatic quantification of
  CMB number, location, and
  iron content
* Automatic report generation
* Queue processing for large
  collections of cases
* Easy-to-use interface

CLINICAL USE:
* Stroke, Dementia, and Traumatic Brain Injury

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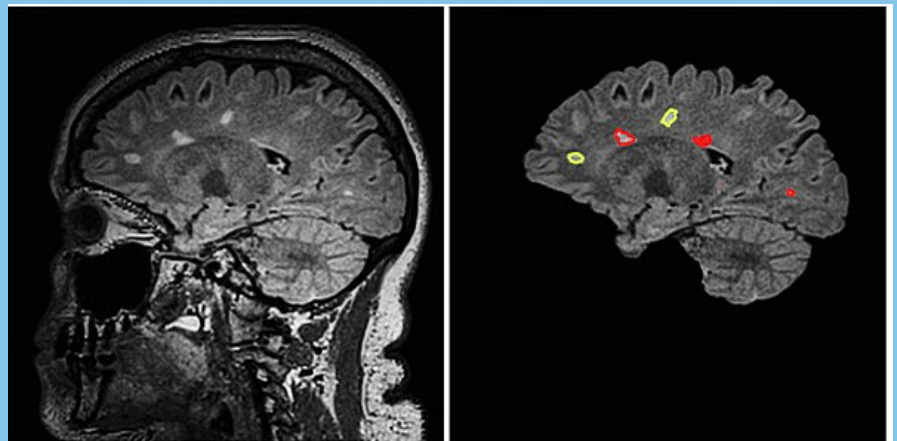rachel.martis-laze@mrinnovations.com

Quantifying White Matter Hyperintensities

SPIN WMH is our advanced post-processing module for automatic detection of **White Matter Hyperintensities (WMH)**. Quantifying white matter lesions has clinical implications for longitudinal tracking of disease progression or drug treatment efficacy. Most current WMH detection software uses semi-automated approaches using multiple MR data sets which requires more processing time. We propose to use only 3D FLAIR data to determine lesion, brain, and ventricle volumes automatically and also label the lesion type. We use a proprietary high spatial frequency suppression method in order to achieve more accurate segmentation results. We also provide several post-processing functions to assist manual segmentation if necessary. No manufacturer yet offers automated WMH segmentation and even our manual segmentation features would compete with what is available.

Features and Clinical Use

FEATURES:
* Efficient and accurate quantification and monitoring of white matter lesions
* Easy to use, robust quantification tool
* Objective and fast interpretation of the MRI data
* Better evaluation of white matter lesions over the course of the disease and its treatment

CLINICAL USE:
* Multiple Sclerosis, Dementia, Parkinson's Disease and Stroke

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Perfusion Weighted Imaging

SPIN PWI is our post-processing module for **Perfusion Weighted Imaging** data. PWI is a well established MRI method for studying cerebral hemodynamics and has found various applications in tumor, angiogenesis and stroke imaging. The hemodynamic characteristics are determined by creating maps of various parameters, such as: cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT) and time to bolus peak (TTP). These parameter maps are derived from the evolution of the intensity of $T2^*$-weighted gradient- or spin-echo, echo-planar images as a gadolinium contrast agent bolus passes through the blood vessels. Using the PWI maps, it is possible to visualize the passage of blood throughout the brain and to identify any regions of abnormal behavior. These hemodynamic parameters can be compared with data from MRA, SWI and SWIM, also processed using SPIN software.
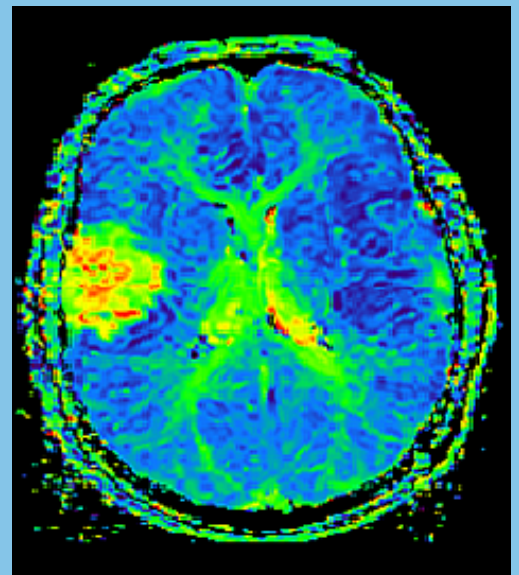
Features and Clinical Use

FEATURES:
* New algorithms for estimating
  perfusion to brain tissue
* Easy to use interface
* Providing error maps for each
   measurement
* Compatible with multi-echo data
* Compatible with data from a double
  injection procedure

CLINICAL USE:
Alzheimer's Disease, Multiple Sclerosis, Stroke and Traumatic Brain Injury.

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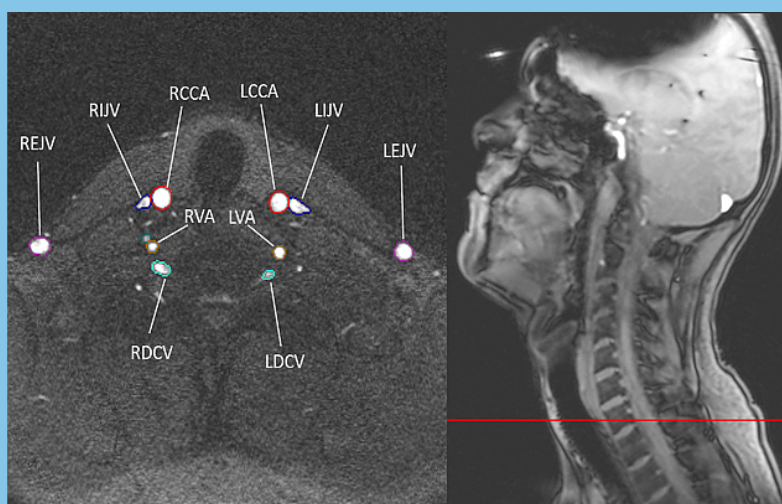www.mrinnovations.com

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FLOW Quantification

SPIN FLOW is our advanced flow quantification module for processing phase-contrast MRI data. SPIN FLOW provides fully automatic segmentation & labeling of all major vessels in the neck and generates corresponding flow measurements. With a single click of the button, SPIN FLOW creates a comprehensive flow report including plots for individual vessels and their corresponding error analysis information.
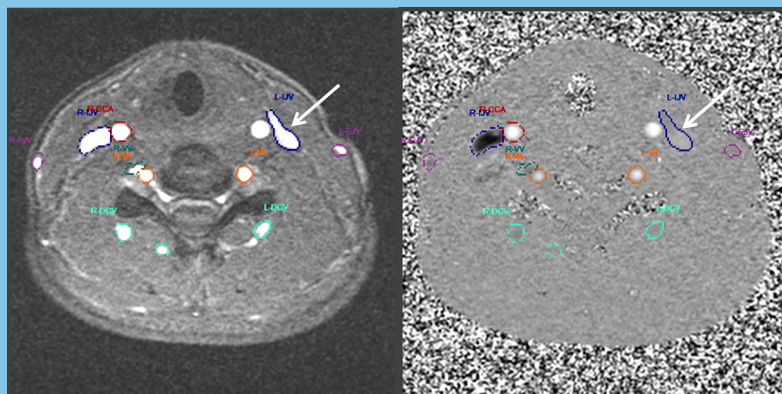
The whole process takes less than five minutes on a regular standalone workstation.

Features and Clinical Use

FEATURES:

* Fast (<5 minutes), objective, and accurate results
* Automatic vessel labeling
* Automatic segmentation of the lumen of the vessel
* Vessels' cross sectional area (CSA) mapping
* Automatic aliasing correction
* Flow error analysis for each vessel
* Standalone or plug-in tool on various workstations

CLINICAL USE:

Stroke, Atherosclerosis, and Cardiovascular diseases