Signa 1.5T EXCITE MR

Producing high-resolution images despite patient movement

Clinical application:
MRI of the brain

The daily caseload in the Department of Radiology at the University of Pittsburgh Medical Center includes a substantial number of brain exams. The hospital's diagnostic equipment includes a GE Signa 1.5 T scanner with EXCITE technology.

Diagnostic challenge:
Solving the problem of patient movement

Patient motion is a significant concern in MR imaging of the brain. "Many patients can hold perfectly still through a complete exam without difficulty," said Emanuel Kanal, M.D., Director of Magnetic Resonance Services at the University of Pittsburgh Medical Center Presbyterian (UPMC). "Other patients can remain motionless for some sequences but not for others. Still other patients move around a little or a great deal and in ways that are not predictable. We also see patients with Parkinson's disease or patients with tremors who may be in motion constantly throughout the exam. Every day in our clinical caseload, as a matter of routine, we see MR images degraded mildly or substantially because of patient motion."

The Signa Excite MR solution:
Propeller T2-weighted imaging

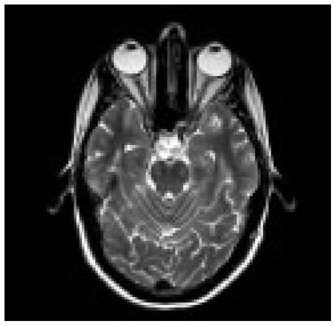
The Department of Radiology upgraded its Signa MR scanner with Propeller imaging, an advanced technology that combines the advantages of fast spin echo (FSE) and radial data acquisition to create high-quality T2-weighted and diffusion-weighted brain images. Propeller improves contrast-to-noise ratio by 20 to 30 percent, significantly reduces the tissue-to-air and tissue-to-metal image distortions of diffusion-weighted imaging, and dramatically reduces the sensitivity of image quality to patient motion.

UPMC uses both Propeller and FSE imaging techniques for T2-weighted imaging on essentially all brain MR exams performed on the Signa MR imaging system.

"When we were introduced to Propeller, motion reduction was just one of several benefits mentioned," said Kanal. "We expected improved signal-to-noise ratio, improved contrast-to-noise ratio and lower sensitivity to field distortion. We do indeed see all those, but by far for us the greatest benefit lies in motion reduction. We have been nothing short of amazed at the motion reduction ability of the Propeller sequence.

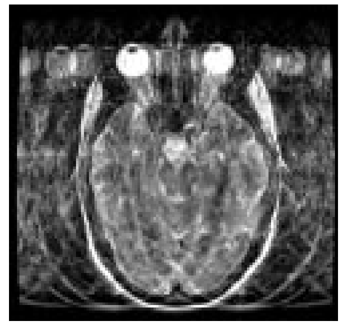
FSE acquisition

Propeller acquisition



Acquisition of a volunteer who did not move during the study.

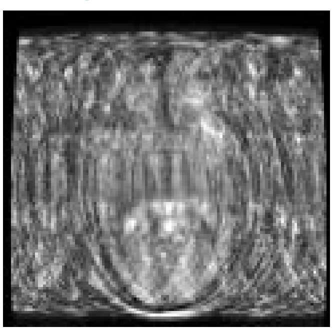
FSE acquisition



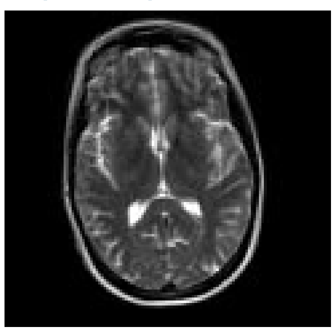
Propeller acquisition

Volunteer who intermittently moved their head 90-degrees to the left, 90-degrees to the right, as far up as possible, and then as far down as possible. Note the absence of motion on the Propeller image.

FSE acquisition

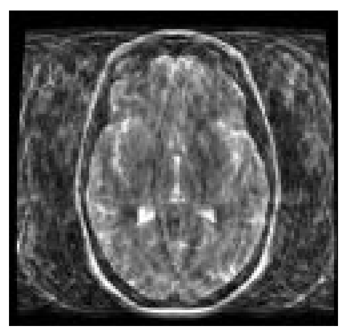


Propeller acquisition

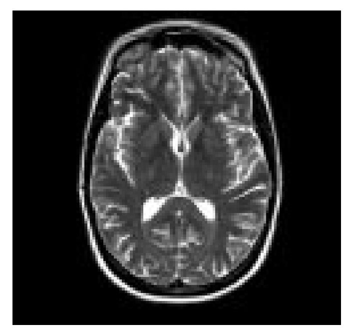


Propeller and FSE acquistion of a volunteer who constantly moved their head 30-degrees from side to side throughout the study. Note the image degradation from motion in the FSE image.

FSE acquisition



Propeller acquisition



Volunteer who intermittently looked in 3 different directions during the scan. Note the lack of motion in the Propeller acquisition.

"Propeller software has two types of motion reduction built in," Kanal observed. "It can detect and correct for rotation and translation in the same plane. For motion that is very severe, and especially motion through a plane, if the software detects that it cannot adequately correct it, then the motion-altered data is rejected entirely."

Kanal conducted formal motion reduction studies at Pittsburgh, using himself as the subject so that he could strictly control and quantify the various types of motion being studied. During exams lasting 2 minutes 42 seconds, he studied six different kinds of motion commonly encountered in clinical settings, which he has labeled as follows:

- Sight-seeing: Intermittent patient motion that entails turning ` and rotating the head randomly in time and space through all three axes, much as a patient might in response to a noise, then returning the head to its original position. This was repeated numerous times during the data acquisition.
- Twitch: Sudden violent head jerks every few seconds throughout the entire examination.
- Coughing: Spasms of five consecutive coughs, repeated every 10 to 15 seconds.
- Continuous coarse motion: Continually rocking the head 30 degrees left, then 30 degree right, every one to two seconds.

This was continued without pause throughout the entire examination.

- Continuous fine motion: Simulating the fine tremor-type motion of a patient with Parkinson's disease, fine continuous head tremors continued without pause throughout the entire data acquisition.
- Maximum/90 degrees rotations: A variation of sight-seeing, this motion consisted of intermittently rotating the head maximally to the right, then to the left, followed by maximal neck extension, and finally maximal neck flexion. This cycle was repeated numerous times throughout the scan acquisition time and was designed to test the robustness of the motion reduction algorithm for both in plane as well as through plane types of patient motion.

As part of the study, motionless images with FSE and Propeller were also taken for study and comparison. Scan times were identical in all FSE and Propeller motionless and motion studies.

In each case, separate exams were conducted with Propeller and standard FSE and then evaluated via side-by-side direct visual comparisons. "In the Propeller sequences, it was difficult if not impossible on many images to even detect that any significant motion had occurred during data acquisition," Kanal said. "Our worst-case motion (continuous coarse motion) still continued to provide diagnostic images on virtually every slice – I would most readily put my name on a report describing the findings of such an exam. In the formal study performed at my site using myself as the volunteer, every image obtained on every slice of each type of motion studied was of diagnostic image quality.

"On the FSE sequences, it was either evident or extremely evident that motion had occurred. On the continuous coarse motion study with FSE, it was difficult even to identify the anatomic region being studied."

Comparisons between Propeller and FSE images from clinical cases show similar results. "In all cases of true patient motion studied to date, the Propeller images are not just better, they are so noticeably and dramatically better that I often end up calling my co-workers to show them the comparisons," Kanal said.

Kanal observed that due to the manner in which Propeller imaging is performed and the new imaging control parameters it introduces, radiologists are required to modify some of their preferred imaging parameters which they had been used to using to date. However, he noted, Propeller is easy to use once those adjustments are made. "I truly cannot overstate the pleasant surprise we experienced in the magnitude, reproducibility and robustness of the motion reduction algorithm inherent in the Propeller software," Kanal said. "Even with the improved signal to noise ratio and the sensitivity to image susceptibility artifacts, it was the tremendously successful and robust motion reduction capabilities that proved to be the benefit of Propeller imaging that we found most noticeable and advantageous to us at the University of Pittsburgh Medical Center. This one is a real winner. I have no doubts that Propeller imaging will succeed in winning over the entire global MR imaging community, and will rapidly become a routine addition to the imaging armamentarium of all clinical and research MR sites."

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