SILENT MR TECHNOLOGY: MOVING BEYOND T1

Creating an entire silent brain exam is integral to GE Healthcare's Humanizing MR mission

During the past two years, GE Healthcare has announced groundbreaking developments in MR that provide quality, affordable care to more people worldwide—underscoring the guiding principle of Humanizing MR.

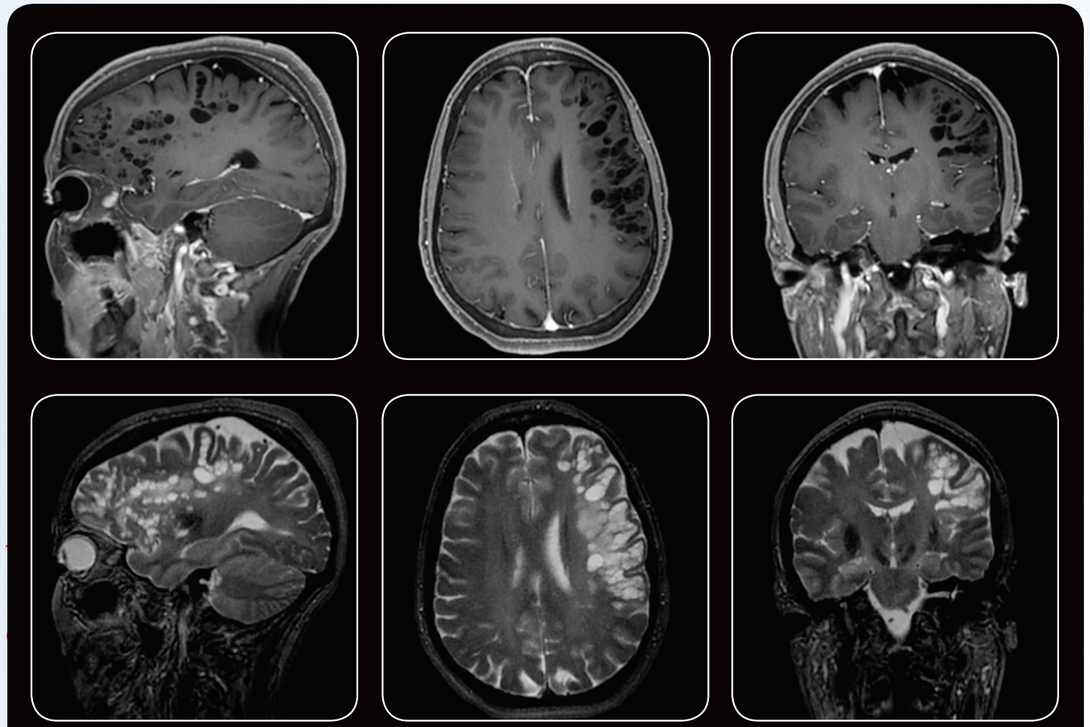
The buzz now is about the introduction of Silent Scan‡, innovative technology designed to address one of the most significant impediments to patient comfort—excessive acoustic noise generated during an MR scan. But GE Healthcare is not stopping there, as the company is in the process of moving beyond T1 to develop an entire silent brain exam (i.e. near ambient noise levels) incorporating all MR imaging contrasts.

"Now that our first step in the journey is completed from a product development perspective, we're branching out into other contrasts with the goal of making those exams more pleasing to patients—while maintaining the best possible diagnostic imaging quality to radiologists," offers Jason Polzin, Chief Technology Leader, Software & Applications, Global MR at GE Healthcare. The goal, explains Bryan Mock, MR Product Manager at GE Healthcare, is to provide clinicians with the tools for a routine, complete brain exam using T1, T2, FLAIR, MRA, and Diffusion, but make it silent.

Yet, according to Dawei Gui, PSD Engineer for GE Healthcare, applying the current Silenz acquisition technology to T2 sequences isn't straightforward. "The commercial product is a gradient echo approach," he says. "So we are currently studying how the concept works in a spin

This article discusses technology in development that represents ongoing research and development efforts. These technologies are not products and may never become products. These technologies are not for sale, are not CE marked, and are not cleared or approved by the FDA for commercial availability.

‡ Silent Scan is not CE marked and cannot be placed on the market or put into service until it has been made to comply with the Medical Device Directive requirements for CE marking. Silent Scan is not available for sale in all markets.

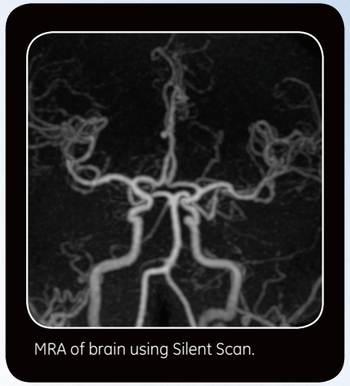


Post contrast T1w and T2w Silent Scan Sagittal acquisition with Axial and Coronal reformats demonstrating dilated Vichow-Robin spaces.

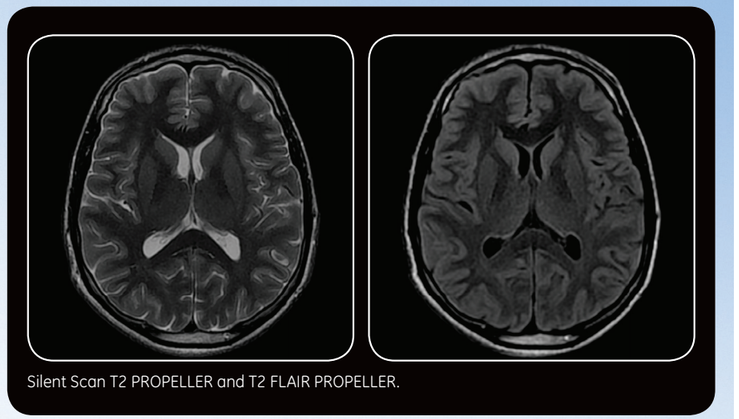
echo approach. We want to reduce noise but maintain SNR, resolution, and image quality." As such, the company is actively pursuing silent T2 contrast by manipulation of sequences to optimize gradient wave forms. "We're interrogating all aspects of conventional MR, and we're looking at innovative ways to obtain T2 contrast like physicians are used to seeing in a silent acquisition," comments Polzin.

GE Healthcare's efforts include leveraging PROPELLER, a fast-spin echo based T2 technique that has excellent motion-insensitive properties and can help eliminate subtle motion artifacts. However, this sequence is still quite loud. Gui and Weisun, Senior PSD/Applications Engineer at GE Healthcare, are taking a hard look at all aspects of these conventional sequences to optimize the gradient waveforms, the fundamental source of noise, to reduce the acoustic signature. This includes eliminating larger crusher gradients, minimizing gradient transitions where unnecessary, and avoiding mechanical frequencies of the magnet/gradient system. "By careful optimization, we are looking at ways to reduce the acoustic noise while maintaining high image quality," offers Gui.

The design goals include the ability to image the vasculature in the brain to look for occlusions and malformations. Doctors need the ability to visualize the vasculature to eliminate problems that may be present in those structures. GE Healthcare is developing a silent MR angiography acquisition that is based on arterial spin labeling preparation pulses, explains Sun. The current technology is based on time of flight (very fast imaging where "unsaturated blood" flows into the slab and appears "bright" compared with surrounding tissue) or contrast-enhanced fast gradient echo imaging (very fast imaging where the contrast is derived from the change in T1 of the blood due to the gadolinium). While both techniques generate images of the brain's vasculature, both sequences often exceed 100 dB of acoustic noise.



MRA of brain using Silent Scan.



Silent Scan T2 PROPELLER and T2 FLAIR PROPELLER.

In the silent technique, the blood within the carotid arteries is "tagged" using a long RF inversion pulse commonly referred to as a "labeling" pulse. Once the blood is tagged, it is allowed to flow into the vasculature and captured by Silenz acquisition. This is followed by the collection of a control dataset where a "labeling" pulse is applied above the head to minimize magnetization transfer effects and to control artifacts. These two datasets are subtracted to eliminate the background, leaving a depiction of the entire vascular tree.

An additional benefit of a conventional or silent ASL technique is the absence of exogenous contrast, adds Mock. "Since the Silenz sequence is a radial 3D acquisition, the data produced is isotropic and can be reformatted into any plane without loss of resolution. In addition, the radial acquisition enjoys a very short TE (~8 us), so the sequence does not suffer from in-plane, intra-voxel flow dephasing."

Going farther

According to Mock, GE Healthcare's next goal is to move outside of the brain. "Silent imaging requires stable power electronics, unique acquisition technologies, and extremely fast RF switching technology in the RF receive coils. Once we have the complete neuro exam validated, then we'll evaluate RF coils to determine which ones can switch fast enough between transmit and receive for high SNR and high artifact-free data outside of the brain." Mock continues, "Our continued research and development includes an evaluation of the hardware, coils, or how it translates to MSK or body, for example. At that point, we expect to also look at adding respiratory gating, navigators, and other motion compensation techniques to enable free-breathing silent body imaging."

Adds Polzin, "These silent sequences are expected to become another tool for radiologists. They could be used for patients intolerant of noise, just as PROPELLER is used for patients who move. There may be tradeoffs, but physicians are seeking solutions that can help them achieve results. Our investment in developing these silent sequences is one element of our commitment to Humanizing MR."

Acknowledgement:

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