B-FFE enables superb pediatric neuro imaging

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Clinicians at Children’s Hospital and Research Center at Oakland (Oakland, California, USA) are using Balanced FFE (B-FFE) in many of their pediatric neuro examinations. It is part of all routine spine exams, and has become the most valuable sequence for diagnosis in almost all the Center’s cranial nerve and spinal nerve root imaging.

Kenneth W. Martin, MD, Associate Director of Neuro Imaging at Children’s Hospital and Research Center at Oakland is using a state-of-the-art upgraded Intera 1.5T and the 6-channel SENSE Head coil for his pediatric neuro patients. He began using B-FFE, a balanced gradient echo sequence, in 2003 while imaging patients that were candidates for a cochlear implant. He needed a very clear image of the eighth cranial nerve, which originates from the brain stem, and goes to the inner ear through cerebral spinal fluid. Before that, Dr. Martin’s routine sequences had been using slice thicknesses from 3 to 6 mm, making it impossible to visualize a 1 mm nerve within 6 mm of other tissue and fluid. He started using the B-FFE images to identify the cranial nerves and was very impressed with the image quality.

“This is a very high resolution sequence; we can take extremely thin slices with it,” he explains. “It’s heavily T2-weighted, and it provides very strong contrast, almost like a silhouette.” It was during the fine-tuning of the spatial resolution in these cranial nerve studies that he became interested in what else the sequence was capable of.

B-FFE helps visualize filum terminale in pediatric spinal canal

“The very first thing that came to mind is the spine and the tiny little nerve roots that come off the end of the spine, especially the cauda equina,” Dr. Martin says. “In adults we would be looking for herniated discs that are pressing on those nerves, but in children, we
were looking for abnormalities that affect a little band of tissues in the spinal canal called the filum terminale. The filum in children is about 1 mm thick, like cranial nerves, and the spinal canal is about 2 cm across. So we adapted our B-FFE sequence, which had already been tuned to produce very high detail, for sagittal scanning of the spine from top to bottom.” This sagittal scan covers the entire spinal cord, all the nerve roots, and, more importantly, the filum terminale with a typical voxel size of 0.48 x 0.48 x 0.5 mm. “Suddenly we were seeing things in the spine that were not visible before and flew in the face of what we’d been taught, such as our understanding of how the filum terminale develops.”

Since then, Children’s Hospital and Research Center at Oakland has added B-FFE to all spine exams. “As an example, there are a group of tumors called dropped metastases that have a propensity to spread through cerebrospinal fluid, and one place they end up is down in the lower spinal canal,” says Dr. Martin. “When we have a patient with one of these tumors, we scan the spine as part of the routine staging evaluation for the tumor, and we can look for these lesions.”

So, in addition to applying B-FFE to visualize anomalies of the spinal cord in babies, the hospital now also uses B-FFE for imaging patients with dropped metastases. “As it turns out, those are the two main reasons that we image the spine in children, especially the spinal canal itself,” says Dr. Martin. “Balanced FFE is superb for identifying problems like this. In fact, taking into consideration all the reasons that we image the spine, it’s almost always the best sequence that we have.”
Versatile sequence for pediatric brain and spine

Dr. Martin also successfully uses B-FFE for imaging of pediatric dermoid and epidermoid cysts. “These are fluid containing cysts, and they image very much like cerebrospinal fluid. So, in some patients you can’t see them at all with routine T1- and T2-weighted imaging. We now use B-FFE, which usually makes these cysts very conspicuous.”

Similarly, arachnoid cysts, which occur within cerebrospinal fluid, are extremely difficult to image because of their thin, lace-like quality. As an example, Dr. Martin mentions a study where on routine sagittal T1- and T2-weighted images the spinal cord looks like it’s being pushed in one direction. “It could be stuck in one direction, or the patient’s spine is curved and it’s taking the shortest pathway between two points or it’s actually being pushed in that direction,” he says. “After we ran the B-FFE scan we didn’t have to guess anymore about which one of those three things it might be. We can actually see the arachnoid.”

There are a number of conditions that occur in or near the brain where physicians have experienced similar limitations. “But in example after example,” says Dr. Martin, “B-FFE has shown to be a very versatile imaging sequence. It’s not a panacea, and it’s not something that we can cover the entire brain with. We use it selectively when we need images with very high detail and where we suspect that a lot of water — like cerebrospinal fluid or a cyst — is involved. This B-FFE technique is a very potent imaging tool.”
Extensively optimized exam protocol with B-FFE differentiates Center
Most MR imaging centers don’t perform this in-depth, but very important scan optimized for children, mainly because they aren’t exclusively engaged in pediatric imaging. Some practices simply perform a sagittal T1-weighted post-contrast image of the spine, but at Children’s Hospital and Research Center at Oakland, exams include axial and sagittal T2-weighted imaging of the whole spine, axial and sagittal post-contrast T1-weighted imaging of the whole spine, and a B-FFE scan of the cauda equina and filum terminale.

“On B-FFE images we have found lesions that were stuck to the nerve roots of the cauda equina, which we could not see on any other image type,” says Dr. Martin. “I can tell you that it makes a tremendous difference in the treatment of a cancer patient. And because the treatment has changed, presumably their outcome has changed as well.”

“As pediatric radiologists, our job is to outperform what anybody else does in imaging for kids,” he concludes. “This is what makes us get up in the morning and come to work. Whether it’s MR or CT or ultrasound, we’re going to do the best we can, and we’re going to try to do it better than anybody’s ever done it before.”

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12-year-old male with diabetes insipidus. T2-weighted and post-contrast T1-weighted images appear normal. B-FFE images of the cauda equina demonstrate a 3 mm nodule attached to nerve roots. This finding changed the follow up. Final diagnosis of metastatic germ.