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The E. Medea Research Institute in the northern Italian town of Bosisio Parini, is dedicated to pediatric rehabilitation. The institute’s Pediatric Imaging Unit uses an Achieva 3.0T. According to pediatric neuroradiologist Filippo Arrigoni, MD, the system’s performance with Philips’ 32-channel head coil is so impressive that they now use this configuration exclusively for all their pediatric neuro examinations.

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Higher resolution: voxel 0.3 x 0.3 x 1.1 mm, TR 5600 ms, TE 15 ms, scan time 21 min.

Higher resolution shows olivary nuclei in medulla
6.5-year-old male suffering from headache. Normal medulla. The higher resolution images (top row) clearly show both olivary nuclei in the medulla (white arrows). With a slightly lower resolution (bottom row) the olivary nuclei can’t be recognized. Achieva 3.0T with 32-channel SENSE Head coil.
The center focuses on the rehabilitation of pediatric patients between the ages of 0 and 18 years with neurological disorders, both congenital and acquired. It chose the Achieva 3.0T for its high-resolution imaging capabilities, which is especially important for accurate diagnosis in pediatric patients. Next to that, Achieva 3.0T was chosen because the center focuses heavily on research into pediatric neurology for which, nowadays, 3.0T is a prime requirement.

“You can’t treat children with neuro disorders like small adults,” says Dr. Arrigoni. “The challenges in imaging their brains are often quite different because their brains are still maturing. What’s more, many of our patients have some form of brain malformation and neuro-degenerative disorder and these continue to develop as their brains develop, so we need to be able to clearly recognize this to understand the morphology. This means that high resolution is the most important criterion for us.”

To achieve this, the Imaging Unit has found the Achieva 3.0T combined with Philips’ 32-channel head coil to be an excellent solution. “The 32 channels can be looked on as a sort of coin that you can spend either on speed or resolution,” he says. “For us speed is not the priority and we have developed sequences focusing on high resolution because we need to go into the finer detail of the pediatric brain anatomy and structure.”

**Cortical layering on high-resolution T2-weighted images**
6.5-year-old male suffering from headache. In these high-resolution images, the cortex doesn’t appear as a uniform “ribbon” but in some areas it shows a complex structure made of 3 layers with different intensities. The central hypo-intense layer is probably the IV cortical layer (band of Ballanger). Achieva 3.0T with 32-channel Head coil. TR 4100 ms, TE 82 ms, voxels 0.43 x 0.43 x 3 mm, scan time 8.30 min.

**Finer detail reveals small alterations in the pediatric brain**
The unit has developed sequences giving very high resolution as fine as 0.3 mm to 1.1 mm which, according to Dr. Arrigoni, produce excellent results in imaging both the normal anatomy of the brain and brain malformations. “We can, for example, easily visualize the olivary nuclei in the medulla – a very small structure that can’t be visualized with normal resolution,” he observes. “And in brain malformations with, for example, heterotopic gray matter or polymicrogyria commonly associated with epilepsy, we can see small alterations in pathology that cannot be visualized without sequences of this kind.”

**Sequences are adapted to each patient**
Dr. Arrigoni works mostly with a slice thickness of 3 mm or less which he believes is essential for performing good exams on children. “This is not only because their brain anatomy is smaller but also because their brains are developing and we need the finer slices to capture subtle changes in the anatomy over time,” he says.

**Normal appearance of hippocampi and mid-brain**
16-year-old male suffering from headache. High detail of hippocampal and mid-brain structure on the axial plane. Both III nerves are well visible. Achieva 3.0T with 32-channel SENSE Head coil. TR 5600 ms, TE 15 ms, voxel 0.3 x 0.3 x 1.1 mm, scan time 21 min.
“We also adjust our sequences to each patient. We first perform a 3D T1 scan on each patient to give us an idea of the problem, after which we can decide which resolution, which type of scan and which TR and TE to use,” says Dr. Arrigoni. “Typically the 3D T1 scan is performed with 1 mm resolution and isotropic voxels from which we can reconstruct images of the brain in all the planes we want. Following this we perform 2-dimensional T2-weighted TSE sequences in two planes, usually axial and coronal with a resolution of 0.45 x 0.45 and 3 mm slices. If we see something interesting, we may decide to use a higher resolution, for example 0.3 x 0.3 and 1.1 mm slices, then FLAIR in two planes with resolution of 0.7 x 0.7 and 3 mm slices.”

Depending upon indications, they then perform specific DTI sequences which they have developed in collaboration with Dr. Pierpaoli at NIH.

“DTI is particularly valuable for the analysis of white matter abnormalities in patients with white matter diseases such as Pelizaeus-Merzbacher disease and MLC (megalencephalic leukoencephalopathy with subcortical cysts), a genetic disease affecting cerebral myelin. These diseases, which are quite rare in the population, have similar patterns under MRI and can be more clearly depicted with DTI, which helps in diagnoses.”

Future ambitions
Dr. Arrigoni and his colleagues also find DTI with the Achieva 3.0T and 32-channel head coil an extremely powerful research tool.

“For example, we have a large group of Duchenne syndrome patients at the institute. This is a disease caused by a genetic anomaly that affects mostly motor function but in some cases also mental function, depending upon the position of the genetic anomaly in the chromosome.

**Neurofibromatosis type 1**
5.5-year-old female with neurofibromatosis type 1 and a small corpus callosum. Multiple hyperintense rounded lesions (white arrows) are evident in the basal ganglia and thalami in the coronal images. Axial images with very high resolution provide a better definition of these lesions. The patient also has a small corpus callosum (sagittal image) with hyperintense lesions in the right Probst bundle (black arrows). DTI tractography shows a small but apparently complete corpus callosum.

Achieva 3.0T with 32-channel SENSE Head coil.

Voxels 0.43 x 0.43 x 3 mm, TR 4100, TE 82

Voxels 0.3 x 0.3 x 1.1 mm TR 5600, TE 15

DTI tractography
The aim here is to use DTI to gain a better understanding of the correlation between genetic pattern and fiber arrangement."

In addition, the group is using DTI to conduct research into the rehabilitation of children with cerebral palsy. "We perform MRI exams on the children before and after intensive rehabilitation therapy and use DTI and fMRI to investigate if any changes in motor function can be related to changes in brain structure to assess the effects of therapy."

"We’re certainly very impressed with the 32-channel Head coil and use it exclusively for all our MRI exams, even though it is rather large for some of our patients," concludes Dr Arrigoni. "This is such an outstanding coil that my hope is that Philips will in future consider introducing a smaller version specifically for pediatric patients."

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**Lissencephaly**

11-year-old female with mental delay and epilepsy caused by a complex brain malformation. A severe lissencephaly with subcortical band heterotopia is evident in the posterior regions of the brain (white arrows). Multiple periventricular nodular heterotopias are also shown (black arrows). The last three images show the axial plane at different resolution. Achieva 3.0T with 32-channel SENSE Head coil.