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EDITORIAL

Advanced pediatric neuroimaging techniques: clinical and research applications

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During the last decade, there has been an explosion in the use of advanced neuroimaging techniques, particularly in the adult population, in both clinical and research domains. These techniques include metabolic (MR spectroscopy and PET), physiological (diffusion and perfusion) and functional (BOLD and MEG) imaging. There is relatively little information in the literature about the application of these techniques to the pediatric population, despite the additive diagnostic clinical information that these techniques can provide. These advanced neuroimaging tools not only allow the opportunity to provide state-of-the-art clinical care to our pediatric patients, but they also allow us to enter into the research domain to address hypotheses that pertain to pediatric neurological disorders. The minisymposium in this month's issue of *Pediatric Radiology* has been written by a collaborative group of pediatric neuroradiologists and scientists who are committed to using advanced neuroimaging techniques in the evaluation of common clinical pediatric neurological problems and also addressing hypothesis-driven neuroscience research questions.

The first article, by Dr. Stefan Blüml and colleagues at Childrens Hospital Los Angeles, describes the technique of quantitative proton MR spectroscopy, which can be used to evaluate metabolism of the brain. This article is derived from an 8-year experience of applying this technique consistently to both normal and abnormal pediatric patients. The article's emphasis is on calculation of absolute concentration of metabolites in the brain compared to the traditional relative ratio analysis. Clinical applications include evaluation of neonatal brain injury, differentiation between neoplastic and non-neoplastic processes and characterization of treatment-related changes in pediatric brain tumors. Research applications include metabolic risk assessment of pediatric brain tumors and metabolic characterization of perinatal white matter injury.

The second article, by Drs. Leach and Holland from the Pediatric Neuroimaging Research Consortium from Cincinnati Children's Hospital, elaborates on the use of BOLD (blood oxygen level-dependent) imaging to perform functional MRI in children. Functional MR imaging has been used extensively by the neuroscience community to address basic research questions, particularly with regard to language development, neurobehavioral and cognitive disorders and visual spatial processing. Most of the current clinical indications for functional MRI are derived from some of this research, and these are covered in this review.

The next article, by Drs. Schwartz, Roberts, and colleagues at Children's Hospital of Philadelphia, describes the technique of magnetoencephalography (MEG), which is another type of functional imaging in which electromagnetic neural activity can be measured with excellent temporal resolution compared to BOLD functional MR. The two major clinical uses of MEG include the preoperative assessment of neurosurgical patients who have lesions in eloquent regions of the cortex and also in epilepsy patients with respect to identifying abnormal interictal or epileptogenic foci. Some of the research applications of MEG include traumatic brain injury (TBI), autism spectrum disorder (ASD) and schizophrenia.

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The article by Drs. Mukherjee, Barkovich, and colleagues combines the University of San Francisco neuroradiology section's authoritative expertise of both diffusion tensor imaging and congenital brain malformations. Diffusion MR principles including high-angular resolution diffusion imaging (HARDI) are reviewed and applied to describing aberrant white matter pathways in different types of congenital brain malformations (with genetic correlation).

Fetal neuroimaging has allowed pediatric neuroradiologists to expand their skills of neuroimaging into the very early time period of gestation and fetal development. The article on fetal neuroimaging by Dr. Orit Glenn, one of the leaders in this field, covers technical aspects and provides clinical examples on how this technique can be used to complement prenatal neurosonography. Research applications, including studying the development of normative diffusion values in the fetal brain, are also elaborated on.

The last article is about the use of positron emission tomography (PET), another metabolic marker, in pediatric neuroimaging. This article, by Dr. Kim et al., represents work from three institutions, showing the collaborative and multi-disciplinary nature of this work. PET is now being integrated more into our clinical domain, particularly in epilepsy imaging and also oncology imaging (lymphoma). The use of PET in the evaluation of pediatric brain tumors is also covered. Future exciting applications including neuroreceptor imaging and combined PET/MRI are also described.

Practical information relevant to C.P.T. coding and billing of these advanced neuroimaging techniques (currently limited to MR spectroscopy, functional MRI, MEG, fetal imaging and PET imaging) is also provided in some of the reviews. I hope that this minisymposium will inspire readers not only to promote the use of these advanced pediatric neuroimaging techniques in everyday clinical practice but also to use them to address specific research questions. Only then can we keep the field of pediatric neuroradiology at the forefront.

Finally, I would like to thank Drs. Slovis, Strouse, and Coley for allowing me the privilege of editing this minisymposium. I would also like to thank Pat Vario from the editorial office for all of her support.