Imaging Advances in the Care of Abused Children: Techniques, Timeliness & Expertise

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Child abuse investigation done correctly is one of the best examples of a helping, caring team; accurate, timely, and technologically excellent data help any team optimize performance. Recent advances in the imaging diagnosis of physical injury associated with child abuse include 1) enhanced imaging techniques affording improved ability to make the diagnosis, and 2) improvements in information dissemination that allow the most expert person to view the images and communicate findings to the other members of the team so that effective child protection and injury investigation are completed in a timely fashion.

Magnetic resonance imaging (MRI) is the most significant recent advance in the imaging of injury. Rapid advances in life support technology and magnet design have made MRI increasingly accessible to the critically injured (Griffiths, Wilkinson, Patel, Romanowski, Mitchell, Graham, Powell, Hodgson, & Paley, 2000). Physics advances in pulse sequences, the gradient switches, receivers, and signal detection offer a wealth of new information. This article briefly discusses two new methodologies, both applicable to brain injury; however, MRI also may be used to advantage in defining injury of other body parts.

Gradient echo imaging, made possible by engineering improvements in pulse gradient switching, offers exquisite sensitivity for detection of intracranial blood. It is likely this technique will be coupled with more conventional MRI sequences to improve both the sensitivity and specificity of detection and characterization of brain injury. As an added benefit, gradient echo techniques are also very fast, facilitating rapid screening of injured children (Yanagawa, Tsushima, Tokumaru, Un-no, Sakamoto, Okada, Nawashiro & Shima, 2000; Noguchi, Seto, Kamisaki, Tomizawa, Toyoshima & Watanabe, 2000; Kuzma & Goodman, 2000).

Diffusion weighted imaging (DWI) is a newly developed and potentially powerful tool for studying the extent and permanence of injury. DWI differentiates cytotoxic edema, caused by cell death, from free fluid, caused by swelling and potentially reversible injury. DWI offers hope for measuring the effects of treatment on children with severe head injury and assists in defining the prognosis for recovery from head injury. Use of a combination of these new sequences promises a whole new understanding of tissue recovery from trauma and vascular insult including the hypoxic ischemic injuries frequently seen in child abuse (Schaefer, Grant & Gonzalez, 2000).

Expertise is an irreplaceable commodity in diagnosing and understanding child abuse injury. Several organizations have recently expanded their interest groups making more experts available to local groups needing assistance. The Society for Pediatric Radiology recently established a committee on child abuse. The Section on Child Abuse and Neglect of the American Academy of Pediatrics is increasingly active in education and consultation. The *Child Abuse Quarterly*, a summary of recent literature on abuse and neglect, has joined the established *International Journal of Child Abuse and Neglect* to increase literature resources and expert reviews for practicing physicians. What makes these experts more valuable, however, is the rapid proliferation of Picture Archiving and Communication Systems (PACS). In theory, any digital image (CT, MRI, nuclear medicine scans) can be viewed by the most expert image interpreter almost instantly after acquisition. This enables rapid, accurate sharing of information with other team members, including investigators and law enforcement. An example of how this benefits abuse investigation occurred in Waterloo, Iowa, where the CT scan of an injured child was rapidly transported to the university so that a pediatric radiologist could review the images and provide input to investigators while they interviewed suspects. Communication by the radiologist to the investigator of the severity and timing of symptoms after injury facilitated rapid rebuttal of false histories of injury and confession of the true mechanisms of injury. Unfortunately, at present PACS units are proprietary and software driven; therefore, transmission is often limited. Considerable work is under way to create a universal standard for intercommunication and the reality of using PACS to get the best expertise in a timely fashion is not far off (Franken, Berbaum, Smith, Chang, Owens & Bergus, 1995).

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