Traumatic Brain Injury- To scan or not to scan?

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Each year there are over 1.7million visits to the emergency room due to concerns of traumatic brain injury (TBI)1. TBI is responsible for approximately 0.6 million emergency room (ER) visits in children 0 to 18 years old and is the leading cause of injury-related morbidity and mortality in this age population with approximately 7500 deaths and 60,000 hospital admissions annually2. Computed tomography (CT) imaging of the brain is the gold standard for evaluation of TBI, quickly and accurately diagnosing lesions (i.e., acute hemorrhage, fracture) that require acute neurosurgical intervention3. When evaluating children with head injuries concerning for TBI one often utilizes the PECARN criteria2 to determine whether a CT is clinically necessary, however despite the PECARN algorithm the number of CT brain scans performed has tripled in the last ten years2. However, there is an increased risk of malignancy – both solid cancer, as well as leukemia – associated with the radiation exposure from CT. Studies have shown that a single head CT in a one year-old child increases the lifetime cancer mortality risk by 0.07%4. Further, although this increased cancer risk is low, if the child has repeated scans for additional future injuries, the cancer risk is increased exponentially with each additional scan resulting in the new diagnosis of leukemia in 1 out of 5,250 CT scans and the new diagnosis of solid cancer in 1:570 and 1:1350 CT scans in females and males less than 5 years old, respectively4,5.

Magnetic resonance imaging (MRI) is an alternative to CT that does not expose a patient to radiation, however due to longer scan times, a child often requires sedation with anesthesia for optimal images. Rapid MRI is a new sequencing technology being used to monitor and follow-up patients with ventriculoperitoneal shunt malfunction and has recently been extended to non-hydrocephalus uses including screening for lumbar puncture, intracranial cyst, macrocephaly and trauma5. Thus, I wanted to research the question: what is the role of MRI vs. CT scans in pediatric patients with traumatic brain injury in diagnosing intracranial hemorrhage (ICH).

Buttram et al. (2015) was a retrospective chart review that showed both CT and MRI can identify hemorrhage and midline shift with good concordance; however, the study was limited due to its retrospective nature and that MRI was completed after CT scan with a median of one day. Roguski et al. (2015), also a retrospective chart review, supported Buttram’s findings suggesting that MRI is as good as or better than CT in identifying ICH. However, in this second study all of the MRIs required sedation as they were full studies, rather than limited studies. Finally, Cohen et al. (2015) looked at the feasibility of rapid MRI (rMRI) – that is the timely completion of the imaging study and lack of any unexpected outcomes due to a clinically significant intracranial injury missed on imaging – in diagnosing pediatric head injury. In this pilot study by Cohen et al., they showed that rMRI is a feasible alternative to CT for imaging of pediatric TBI in the ED, however the study was limited in that patients did not receive the gold standard CT in addition to rMRI.

Overall, these studies suggest that MRI is comparable to CT in identifying hemorrhage in TBI. rMRI is a promising alternative to CT that does not require sedation when identifying children at risk for ICH after TBI. However, additional factors including the higher cost of MRIs vs. CT and the availability of the MRI scanner must also be taken into account in determining the applicability of using rMRIs in identifying children with ICH. Given this preliminary data, future prospective randomized case-control studies are needed in which patients receive both the gold-standard CT scan as well as rMRI to determine whether rMRI is a feasible, effective, and diagnostic alternative to CT that would not only significantly decrease a child’s risk of malignancy, but also successfully identify children with an ICH requiring medical or surgical intervention.

References:

1www.cdc.gov/traumaticbraininjury/pdf/tbi\_blue\_book\_age.pdf

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3Buttram, S., et al. 2015. Computed tomography vs. magnetic resonance imaging for identifying acute lesions in pediatric traumatic brain injury. Hospital Pediatrics 5(2): 79-84.

4 Roguski, M., et al. 2015. Magnetic resonance imaging as an alternative to computed tomography in select patients with traumatic brain injury: a retrospective comparison. Journal of Neurosurgery Pediatrics 15: 529-534.

5Cohen, AR., et al. 2015. Feasibility of “rapid” magnetic resonance imaging in pediatric acute head injury. American Journal of Emergency Medicine 33: 887-890.