Cervical Spine in abusive head trauma

Spinal imaging has been a neglected part of abusive head trauma (AHT) imaging. As most of the radiographs and CT spine are negative in AHT in infants, the cervical spine is assumed to be normal. There is increasing evidence in the role of injury to brainstem and cervical cord in the pathogenesis of AHT. In addition, in courts of law, there is fierce debate about AHT, its mimics and other disparate nontraumatic diagnoses explaining the neuroradiological and skeletal findings. However, this discussion ignores the evidence and significance of spinal injury [1)].

Results highlight variation across hospitals in adjusted probability of cervical imaging in AHT (nearly 20-fold) and TBI from falls (over 10-fold) not explained by observed patient characteristics. This variation suggests opportunities for further research to inform imaging practices [2)].

C-spine MRI may identify abnormalities not apparent upon physical examination and the procedure should therefore be considered in cases of suspected AHT [3)]. However, severe c-spine injury remains rare, and increased use of cMRI might not affect outcomes markedly [4)].

Case series

2017

A total of 503 patients were treated between 2009 and 2014 at a single pediatric Healthcare system were identified from a prospectively maintained database. Additional data on selected clinical events were retrospectively collected from electronic medical records. In 2012, a clinical pathway on cMRI usage for patients with NAT was implemented. The study compared cMRI use and clinical outcomes between the prepathway (2009-2011) and postpathway (2012-2014) periods.

There were 249 patients in the prepathway and 254 in the postpathway groups. Incidences of cranial injury and Injury Severity Scores were not significantly different between the 2 groups. More patients underwent cMRI in the years after clinical pathway implementation than before (2.8% vs 33.1%, $p < 0.0001$). There was also a significant increase in cervical collar usage from 16.5% to 27.6% ($p = 0.004$), and more patients were discharged home with cervical collar immobilization. Surgical stabilization occurred in a single case in the postpathway group.

Heightened awareness of potential c-spine injury in this population increased the use of cMRI and cervical collar immobilization over a 6-year period. However, severe c-spine injury remains rare, and increased use of cMRI might not affect outcomes markedly [5)].

Retrospective study of children under the age of 5 years with AHT admitted to hospital in 2004-2013. Those with c-spine MRI were identified, and the images were reviewed.

250 AHT cases were identified, with 34 (14%) undergoing c-spine MRI. Eleven patients (32%) had 25 findings, including hematoma in 2, occiput-C1-C2 edema in 3, prevertebral edema in 6, facet edema in 2, and interspinous and/or muscular edema in 10. No patients had a clinically evident c-spine injury, a clinically unstable c-spine, or required c-spine surgery.

C-spine MRI may identify abnormalities not apparent upon physical examination and the procedure

should therefore be considered in cases of suspected AHT [6].

2016

Of 2347 children with TBI, 18.7% were from abuse and 57.1% were from falls. Fifteen percent of children with TBI underwent advanced cervical imaging. Moderate or severe head injuries were associated with increased odds of cervical imaging in AHT (odds ratio 7.10; 95% confidence interval 2.75, 18.35) and falls (odds ratio 2.25; 95% confidence interval 1.19, 4.27). There was no association between annual hospital volume of injured children and cervical imaging performance. The adjusted probability of imaging across hospitals ranged from 4.3% to 84.3% in AHT and 3.1 to 39.0% in TBI from falls ($P < .001$).

These results highlight variation across hospitals in adjusted probability of cervical imaging in AHT (nearly 20-fold) and TBI from falls (over 10-fold) not explained by observed patient characteristics. This variation suggests opportunities for further research to inform imaging practices [7].

2014

The purpose of a study was to compare the relative incidence of spinal ligamentous and soft-tissue abnormalities on spinal MRI among three groups of children ages <48 months: 1) those with AHT, 2) those with accidental trauma, and 3) those with nontraumatic conditions.

This comparative study included 183 children who underwent spine MRI: 67 with AHT, 46 with accidental trauma and a clinical suspicion of spinal injury, and 70 with nontraumatic conditions. Clinical and radiographic findings were collected in all cases and were analyzed retrospectively to identify MRI evidence of traumatic spinal injuries. The incidence of spinal injuries among the three groups was compared. The incidence of spinal ligamentous injuries was calculated for those with and without radiographic evidence of hypoxic-ischemic encephalopathy. All comparisons were performed using Fisher exact test with $P < 0.05$ considered statistically significant.

Cervical spine ligamentous injuries (predominantly the nuchal, atlanto-occipital and atlanto-axial ligaments) were present in 78% of the AHT group, 46% of the accidental trauma group and 1% of the nontraumatic group; all of these differences were statistically significant. Among the AHT group, ligamentous injuries were statistically correlated with evidence of brain ischemia.

Injury to the cervical spinal posterior ligamentous complex is common in AHT and even more prevalent than in clinically symptomatic traumatic cases. The high correlation between the radiographic findings of occipitocervical ligamentous injuries and hypoxic-ischemic brain injury is consistent with an interpretation that transient upper occipitocervical spinal cord injury in AHT leads to disordered breathing and results in hypoxic-ischemic encephalopathy. They recommend imaging the entire spine in AHT to properly identify and classify these injuries [8].

[1], [8]
Choudhary AK, Ishak R, Zacharia TT, Dias MS. Imaging of spinal injury in abusive head trauma: a retrospective study. Pediatr Radiol. 2014 Sep;44(9):1130-40. doi: 10.1007/s00247-014-2959-3. Epub 2014 Apr 1. Erratum in: Pediatr Radiol. 2015 Apr;45(5):784. PubMed PMID: 24687620.
[2], [7]

Henry MK, Zonfrillo MR, French B, Song L, Feudtner C, Wood JN. Hospital Variation in Cervical Spine Imaging of Young Children With Traumatic Brain Injury. Acad Pediatr. 2016 Sep-Oct;16(7):684-91. doi: 10.1016/j.acap.2016.01.017. Epub 2016 Feb 4. PubMed PMID: 26854208; PubMed Central PMCID: PMC4974148.
[3] [6]
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Governale LS, Brink FW, Pluto CP, Schunemann VA, Weber R, Rusin J, Fischer BA, Letson MM. A Retrospective Study of Cervical Spine MRI Findings in Children with Abusive Head Trauma. Pediatr Neurosurg. 2017 Oct 31. doi: 10.1159/000481511. [Epub ahead of print] PubMed PMID: 29084406.
[4] [5]
,
Oh A, Sawvel M, Heaner D, Bhatia A, Reisner A, Tubbs RS, Chern JJ. Changes in use of cervical spine magnetic resonance imaging for pediatric patients with nonaccidental trauma. J Neurosurg Pediatr. 2017 Sep;20(3):271-277. doi: 10.3171/2017.2.PEDS16644. Epub 2017 Jun 30. PubMed PMID: 28665242.