Head and Cervical Spine Evaluation for the Pediatric Surgeon

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KEYWORDS

• Pediatric trauma • Cervical spine • Traumatic brain injury • Imaging • Evaluation

KEY POINTS

- Head Evaluation
  - Traumatic brain injury (TBI) is the most common cause of death among children with unintentional injury.
  - Patients with isolated loss of consciousness and Glasgow Coma Scale (GCS) of 14 or 15 do not require a head CT.
  - Maintenance of normotension is critical in the management of the severe TBI patient in the emergency department (ED).
- Cervical spine evaluation
  - Although unusual, cervical spine injury (CSI) is associated with severe consequences if not diagnosed.
  - The pediatric spine does not complete maturation until 8 years and is more prone to ligamentous injury than the adult cervical spine.
  - The risk of radiation-associated malignancy must be balanced with the risk of missed injury during.

HEAD EVALUATION

Introduction

The purpose of this article is to guide pediatric surgeons in the initial evaluation and stabilization of head and CSIs in pediatric trauma patients. Extensive discussion of the definitive management of these injuries is outside the scope of this publication.

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The diagnostics and management strategies contained within this text are written in the context of the ED or trauma bay.

TBI is a broad term and refers to an acquired condition that results in temporary or permanent alteration in brain function. GCS is frequently used to classify TBI as mild (14–15), moderate (9–13), and severe (3–8).[1] The GCS is not as well validated for pediatric populations nor does it hold the same prognostic value as for adults.[2,3]

In the United States, the primary cause of death for individuals aged 0 to 14 years of age is unintentional injury, with TBI the injury most often associated with death.[4,5] This population group is estimated to experience more than 500,000 TBI events per year, the majority caused by falls and being struck by or against an object.[6,7] From the 2001 to 2002 to 2009 to 2010, the number of TBI-related ED visits doubled for patients aged 0 to 4 years of age.[8]

Nonaccidental trauma (NAT) was responsible for 80% of serious or fatal TBIs.[9] Nationwide, this leads to approximately 800 deaths annually.[10] (For more information regarding NAT, see Paul Kim and Richard A Falcone's article, "Non-accidental Trauma in Pediatric Surgery," in this issue).

Relevant Anatomy and Pathophysiology

Commonly used nomenclature for TBI includes intra-axial and extra-axial. Intra-axial lesions refer to injuries of the brain parenchyma and include diffuse axonal injury (DAI), contusions, infarctions, and cerebral edema. Extra-axial injuries are outside the brain parenchyma and contain skull/facial fractures and hemorrhage (epidural, subdural, and subarachnoid).[11,12]

Although contusions and infarctions are more discrete injuries, DAI (also referred to as traumatic axonal injury) involves larger portions of the brain, although not necessarily uniformly. DAI occurs when the brain experiences angular, or rotational, forces causing a shearing effect on neurons.[11,12]

A few interrelated concepts must be discussed to understand normal brain physiology and the perturbations that are associated with TBI. The Monro-Kellie doctrine states that the cranial vault contains a fixed volume, and the sum of the volumes of the brain, intracranial blood, and intracranial cerebrospinal fluid is constant. The brain is relatively incompressible and the blood and cerebrospinal fluid volumes vary. In children, prior to fusion of the fontanels, there is some expansion in the cranial volume.[13,14] Furthermore, newer research suggests that in intracranial hypertension (ICH), excessive pressure is not equally exerted on all portions of the brain.[15]

Damage to the brain may occur not only as a result of the primary injury but also from postinjury factors, such as hypotension, hypoxemia, pyrexia, hypoglycemia, and cerebral edema (secondary injury). Secondary insults vary in both preventability and reversibility and may result from both systemic and intracranial factors.[16,17]

Cerebral perfusion pressure (CPP) is defined as the difference between the mean arterial pressure and the intracranial pressure (ICP). Generally, the ideal CPP is 70 mm Hg for an adult patient.[18] Children are known, however, to have greater tolerance of low CPP and the ideal CPP is unclear for children. The youngest children tolerate the lowest values off CPP, with the ideal value falling between 30 mm Hg and 40 mm Hg.[19]

Cerebral blood flow (CBF) is maintained over a wide range of both CPP and ICP. As a function of systolic blood pressure, CBF is maintained when SBP ranges from 60 mm Hg to 150 mm Hg through autoregulation. Autoregulation of CBF may be perturbed by trauma, hypoxia, or hypercarbia.[17,20]

Important physiologic differences between adults and children include greater elasticity of the cranial vault and tolerance of lower CPP in the pediatric population.