Head injuries in children continue to be a challenge for most family physicians. Some of these challenges include evaluation of a child and assessing the need for conducting an investigation. Another is the need to educate parents about vigilance at home on how to prevent head injuries. Perhaps the most challenging of all is the need to include the possibility of child abuse when examining children with head injuries, especially those under the age of one year.

The mechanisms of injury vary with age. In younger children, head injuries are usually due to falls and child abuse; in older children, sports injuries and motor vehicle accidents are the main causes. The majority of patients have minor head injuries, but although most of these injuries are insignificant, minor head trauma can cause intracranial injuries. Although computed tomographic (CT) scans of the head can identify intracranial injuries with high sensitivity, universal imaging of all children with minor head injuries is not warranted, given available

Children who present with a history of head injuries are challenging, because there are many unknowns. Those with intracranial hemorrhages may initially present with subtle findings, and must be carefully checked.

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resources and the risks of sedation. The physician’s goal when managing children with minor head trauma is to identify those who are at risk for intracranial injury, while at the same time, limiting the use of unnecessary imaging procedures.

The following article will review the types of head injuries that occur in children and infants, and how to evaluate the head-injured child. It will focus on a family physician’s assessment of minor head injuries in the office, and decisions about the need for investigation or admission, as well as the management of head injuries in infants.

Types of Head Injuries

Head injuries include skull fractures and intracranial injuries. Skull fractures are described as linear, depressed or basilar. Linear skull fractures have an increased potential for intracranial hemorrhage if the fracture crosses the path of a major vascular structure, such as the middle meningeal artery. Depressed skull fractures can be difficult to detect because of a large hematoma at the site. Basilar skull fractures are usually detected by clinical signs because the fracture is difficult to appreciate on skull films. A fracture of the petrous part of the temporal bone could cause hemotympanum, otorrhea and Battle’s sign (bleeding into the mastoid air cells). A fracture of the base of the skull anteriorly can lead to a dural laceration and rhinorrhea. A fracture causing disruption of the anterior venous sinus will cause blood leakage into the periorbital tissues and lead to “raccoon eyes.”

The presence of a skull fracture indicates that significant force has been inflicted by the injury and increases the likelihood of the presence of an intracranial injury. An intracranial injury, however, can occur without the presence of a skull fracture.

Growing skull fractures, or leptomeningeal cysts, are rare complications of skull fractures, occurring most often in children under three years of age.

The most common brain injury in children with severe head injury is diffuse brain swelling. These children present with a depressed level of consciousness and may have focal neurological signs.

The history of a child who presents with a head injury must include precise details about the injury. This will provide a clear picture of how the injury occurred. The behavior of the child after the event also is significant and would include any loss of consciousness, vomiting, amnesia, headache, seizures, drowsiness, visual problems, irritability or neck pain.

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years of age. They occur when a fracture is accompanied by a dural tear, allowing pulsation of the CSF or herniated meninges to remodel the bone. These skull fractures can become evident months to years after the initial injury, with a skull defect or an enlarged fracture showing up on skull film, or when a seizure occurs. Progressive brain damage can occur if the defect is not detected and surgically repaired. Children under three years of age should be examined two to three months after their fracture for this complication, which may occur several years later.

Intracranial injuries are categorized as the following:

- Functional abnormalities without demonstrable lesions on imaging;
- Hemorrhages; and
- Diffuse brain swelling.

Functional abnormalities would include concussions and post-traumatic seizures. A concussion is defined as a head injury followed immediately by a period of unconsciousness. This may be associated with amnesia for events preceding (retrograde) and following (antegrade) the injury. Post-traumatic seizures may be instantaneous, early or late in their onset. The occurrence of a seizure is always a concern because of the possibility that damaged brain tissue has triggered the episode. The relevance of a seizure depends on the timing of the episode. Immediate seizures — within seconds — are brief impact seizures due to traumatic depolarization and do not require investigation if the child is entirely well on examination. Early seizures occur within 24 hours and are due to focal injuries. Late seizures occur over one week after the injury and are due to scarring from local vascular compromise. Both early and late seizures require imaging to determine the cause of the seizure.

Hemorrhages include cerebral contusions, epidural and subdural hematomas and intracerebral hemorrhages. Children suffering from hemorrhages may present with loss of consciousness, headache and vomiting. Subdural hematomas are the most common post-traumatic hematomas in children. Epidural hematomas are often associated with an overlying fracture and classically present with an initial loss of consciousness, a lucid interval and then neurological deterioration. Intracerebral hemorrhages are unusual and result from severe focal injury or penetrating trauma. There is severe neurological compromise and the patient has a poor prognosis.

The most common brain injury in children with severe head injury is diffuse brain swelling. The children present with a depressed level of consciousness and may have focal neurological signs.

The presence of a skull fracture increases the likelihood of the presence of an intracranial injury, but an intracranial injury can occur without a skull fracture.

Evaluation of Children With Head Injuries

Any evaluation of a child begins with a thorough history. The history of a child who presents with a head injury must include precise details about the injury. This will provide a clear picture of how the injury occurred. The behavior of the
child after the event also is significant and would include any loss of consciousness, vomiting, amnesia, headache, seizures, drowsiness, visual problems, irritability or neck pain. The timing of the event is also essential because it will determine further management. Children who are well 12 hours after the incident are of less concern and require less close observation than children who present within an hour of the incident. The child’s past medical history may be useful if there is a history of coagulation problems. Most importantly, the physician must determine if the injury could have occurred as reported. Unfortunately, non-accidental injury occurs in children. In the young or non-verbal child, the physician’s suspicions about the real cause of the injury may be the child’s only opportunity for future protection.

Following the history, a physical examination must be performed. A general examination would include examination of the child’s head, neck, chest, abdomen, extremities and vital signs to check for coexisting injuries and evaluate for signs of a skull fracture. The neurological examination would include documenting the child’s level of consciousness. Although the Glasgow Coma Scale (GCS) (Table 1) is used universally in adults, it is difficult to use in younger children because of their preverbal status. The child’s mental status can be assessed on the alert, verbal, painful, unresponsive (AVPU) scale, in which patients are described as alert, responsive to verbal stimuli, responsive to painful stimuli or unresponsive. The neurological examination also should include an examination of the cranial nerves, motor and sensory function, deep tendon reflexes and gait.

Minor head injuries in children cause pronounced physical signs and symptoms as compared to adults. Children are more likely to exhibit pallor, lethargy, emesis, headaches and dizziness with no underlying cause. These children require close observation to check for progression or lack of resolution of such symptoms, which would prompt investigation.

Table 1

<table>
<thead>
<tr>
<th>The Glasgow Coma Scale</th>
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<tbody>
<tr>
<td><strong>Motor response</strong></td>
</tr>
<tr>
<td>Obeys verbal commands  6</td>
</tr>
<tr>
<td>Localizes to painful stimuli 5</td>
</tr>
<tr>
<td>Flexion withdrawal 4</td>
</tr>
<tr>
<td>Abnormal flexion 3</td>
</tr>
<tr>
<td>Extension 2</td>
</tr>
<tr>
<td>No response 1</td>
</tr>
<tr>
<td><strong>Eye opening</strong></td>
</tr>
<tr>
<td>Spontaneously 4</td>
</tr>
<tr>
<td>To verbal command 3</td>
</tr>
<tr>
<td>To pain 2</td>
</tr>
<tr>
<td>None 1</td>
</tr>
<tr>
<td><strong>Verbal response</strong></td>
</tr>
<tr>
<td>Oriented — converses 5</td>
</tr>
<tr>
<td>Disoriented — converses 4</td>
</tr>
<tr>
<td>Inappropriate words 3</td>
</tr>
<tr>
<td>Incomprehensible 2</td>
</tr>
<tr>
<td>No response 1</td>
</tr>
</tbody>
</table>

Management of Head Injuries

Head injuries are classified by the patient’s level of consciousness as defined by the Glasgow Coma Scale.
Scale or AVPU in pre-verbal children. Children with severe head injuries have a GCS score of less than or equal to 8. They present to the emergency room and require imaging, usually in the form of a head CT scan. Children more often present with diffuse brain swelling and intracranial hypertension as compared to adults who tend to present with hemorrhages. As a result, children are less likely to have surgically amenable lesions and emergency burr holes are rarely done. Management of increased intracranial pressure includes elevation of the head of the bed, sedation, diuretics, such as mannitol, and ventilation.\(^1\)

Children with moderate head injuries have a GCS score of 9 to 12 and require imaging, as well as hospital admission until they are symptomatically improved. Children with minor head injuries have a GCS of 13 to 15. The American Academy of Pediatrics (AAP) defines children with minor head injury as those with normal mental status at the initial examination, no focal neurological deficits, no physical evidence of skull fracture, temporary loss of consciousness (duration less than one minute) with injury, possible seizure immediately after the injury, possible vomiting after the injury or possible signs and symptoms, such as headache and lethargy.\(^2\) Children with minor head injuries who initially appear to be at low risk can deteriorate with secondary brain injury. The goal of the physician in managing children with minor head trauma is to identify those clinically well patients at risk for intracranial injury who may deteriorate over time if left untreated. Many studies have shown that very few pediatric patients with minor head trauma develop significant hematomas that require surgical intervention.\(^3\) This makes it dif-

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It is difficult to justify imaging all these children. Concern exists, however, that the rare case will be missed and lead to serious subsequent deterioration. Also, studies have not been able to identify a set of criteria that clearly predicts intracranial hemorrhages in children with a normal neurological status. The AAP’s consensus guidelines for the management of children over the age of two years with minor head injury recommends no head imaging unless there is a history of loss of consciousness. Schutzman and Greenes propose other management guidelines, suggesting that loss of consciousness has poor sensitivity and specificity to predict intracranial injury, and that CT imaging also should be considered in children with a history of amnesia, seizure, headache, persistent vomiting, irritability or behavioral change. There has been a recent publication entitled: “The Canadian CT Head Rule for patients with minor head injury.”

Through consultation with 10 adult emergency rooms across Canada, a decision rule was established for the use of CT scanning in minor head injuries, defining high and medium risk factors predicting the need for surgical or neurological intervention. Unfortunately, the study excluded patients under 16 years of age.

Children with normal head CT scans and normal neurological examinations can be discharged safely, provided parents can be relied upon to observe and return them to the hospital if there are persistent or progressive symptoms. If there is a persistent, but decreasing, headache, acetaminophen is recommended. More potent analgesics should be avoided, as they may mask any progression of symptoms. Children with normal head CT scans, but persistent symptoms, may require admission to hospital for neurological observation and bed rest. The child should not be discharged until he/she is asymptomatic with a normal neurological examination. Every caregiver should be given clear instructions, detailing signs in the child that would prompt a return to hospital for reassessment.
Head Injuries in Infants

Head injuries in infants are more difficult to evaluate because they do not have a typical presentation. The history may or may not include an incident. The baby may present with only a history of increased irritability, persistent emesis or an altered level of consciousness. Signs of increased intracranial pressure include a bulging fontanelle, bradycardia or a “setting sun” sign (i.e., inability to open the eyes fully). Any baby with signs of increased intracranial pressure requires admission and further investigations. In these situations, there should be a high degree of suspicion regarding the mechanism of injury, and appropriate steps should be taken to protect the infant.

Often, a distraught parent may present with a baby who has rolled off the changing table or sofa onto the floor. A detailed history should reveal the circumstances leading to the event, the behavior of the baby after the fall and the feasibility of the event actually occurring as it was described. The examination will provide much information, mainly because, in the majority of simple vertical falls of less than four feet, in 40% of infants, there is no evidence of injury. In 45% of infants, there is only evidence of minor injury, such as abrasions or hematomas. In only 15% are there significant injuries, such as long bone fractures or closed head injuries. In these 15%, further investigations, such as skeletal surveys and head CT scans, are necessary to evaluate for child abuse. It is unusual for complex injuries to occur given a low force mechanism of injury, such as a straight fall from a low surface.

The issue of routinely performing head CT scans in infants has been raised, just as routine head CT scans in children post-injury have been queried. In children and adults, clinical features may be more predictive of the extent of intracranial injury, but in infants, this approach is unreliable. A retrospective study of infants with intracranial injuries documented on head CT scan, showed only 81% to be symptomatic with clinical features, such as loss of consciousness, behavioral changes, vomiting, seizures and bulging fontanelle. The remaining 19%, who were asymptomatic, tended to be less that 12 months of age, and 95% had skull fractures. Although none of these babies suffered neurological deterioration, the possibility of intracranial injury could not be excluded, despite their lack of symptoms. Subsequently, criteria were developed to determine which asymptomatic infants under 12 months of age require imaging. The correlation with skull fractures was found to be significant, therefore, any infant with a scalp hematoma, a marker for skull fracture, should be investigated using either a skull X-ray or CT scan. Asymptomatic infants without scalp hematoma require no further investigations.

Conclusion

Children who present to the office with head injuries continue to be challenging, because there are many unknowns. Details about the incident may be lacking if it was not witnessed by an adult. An infant’s clinical presentation may be unhelpful. The fact that the history of the infant’s injury given by the accompanying adult may be unreliable makes the physician’s evaluation of the infant or child of paramount importance.

In older children, where the mechanism of injury is known, the question remains as to when imaging is required. The criteria for determining whether or not the child requires further investigations include loss of consciousness, amnesia, seizure, headache, persistent vomiting, irritability or behavioral changes. Unfortunately, none of
these signs and symptoms is predictive of intracranial injury requiring surgical correction. Although head CT scans are performed on many children with no intracranial lesions, the consensus is to try and avoid missing children with intracranial hemorrhages who may present initially with subtle findings.

In any child where the details of the incident are suspicious, it is essential that specialists in child protection be consulted. In order to protect the child, admission to hospital may be warranted, if only for an observation period of the child and adult, even when no investigations are required. Short vertical falls in infants generally do not cause significant injuries and any complex injuries associated with such a history should lead to suspicion about the mechanism of injury.

The presence of a skull fracture in an infant requires further investigation, even if the baby is entirely clinically well. There is a solid correlation between skull fractures and intracranial injuries in infants.

References

Suggested Readings