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Whiplash Shaken-Baby Syndrome Causing Cervical Cord Injury Without an Identifiable Radiographic Abnormality: A Case of SCIWORA

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Victims of child abuse typically reach medical attention with visible physical signs of injury. In shaken-baby syndrome; however, clinical findings often reflect neurological deficits while plain radiography or CT may appear normal. Infants who sustain neurological impairment despite normal radiographic and CT findings must be evaluated with MR imaging to rule out a cervical spinal cord injury.

Key Words: child abuse, injury, SCIWORA, spinal cord, trauma, whiplash shaken-baby syndrome

Abbreviations Used: CT, computed tomography; MR, magnetic resonance; SCIWORA, spinal cord injury without radiographic abnormality

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SCIWORA can be seen in pediatric patients who have sustained direct impact injuries. SCIWORA is most often evident in the cervical spine because the hypermobility of the region allows excessive flexion and extension.² Direct spinal trauma caused by accidental or nonaccidental trauma is usually accompanied by other abnormalities seen on plain radiography or CT. There are cases, however, in which patients have neurological deficits despite negative radiographs and CT scans; thus, MR imaging is critical to rule out the presence of a spinal cord injury. We present the case of an abused infant who had no intracranial damage but who did sustain cervical damage, a condition known as whiplash shaken-baby syndrome. In this case the patient's plain radiographs and intracranial CT scans were normal, but his cervical MR imaging study was abnormal.

Case Report

An 8-month-old boy, with no significant medical history, was brought to the emergency department for the sudden onset of bilateral upper extremity paralysis and dyspnea. His parents stated that the child was irritable, weak, and breathing rapidly.

On examination, the boy was in mild respiratory distress and appeared lethargic. He was normocephalic and atraumatic. Neurologically, his pupils were equal, round, and reactive to light and accommodation. He had no upper extremity movement and did not withdraw to painful stimulation. His lower extremity function was within normal limits. The remainder of his neurologic examination was unremarkable.

His white blood cell count and the level of his electrolytes were normal. A lumbar puncture was performed. Approximately 15 cc of clear fluid was sent for laboratory analysis. The sample showed a significant elevation of his white blood cell count but was gram-stain negative.

Anteroposterior and lateral cervical spine radiographs showed no fractures or subluxation (Fig. 1). A fluoroscopic examination showed no evidence of instability. CT of the head was negative for intracranial hemorrhage, fractures, or soft tissue abnormalities (Fig. 2). T2-weighted MR images of the cervical and thoracic spine showed abnormal signal intensity within the cervical cord (Fig. 3).



Figure 1. Plain lateral radiograph of the cervical spine of an 8-month-old boy with mild respiratory distress is normal.

Discussion

In the past 20 years, the incidence of SCIWORA as a result of child abuse has increased 400%.⁵ Each year the number of estimated cases ranges from 600 to 1400. The incidence of SCIWORA is highest in young patients. In fact, most cases of SCIWORA involve infants before their first birthday. The mean age of patients ranges between 3 and 8 months old.

SCIWORA accounts for about 63.1% of spinal injuries in children 0 to 9 years old and for about 19.7% of the injuries in children between the ages of 10 and 17 years.⁵ SCIWORA often involves the cervicothoracic junction.

Mechanism of Injury

Extension is often the primary cause of SCIWORA. It is most often caused by a direct impact sustained in a motor vehicle accident or by a fall from a height.² In contrast, victims of shaken-baby syndrome experience recurring flexion and extension of the cervical region, a motion that is immensely aggravating to the spinal cord.⁶

The severity of SCIWORA correlates with age and is related to the elasticity and hypermobility of the immature spine. Compared to older children, younger children are less likely to sustain osseous spinal trauma such as fractures. However, when young children do sus-



Figure 2. Axial noncontrast head CT shows no intracranial hemorrhage.

tain spinal trauma, their immature spinal architecture increases their vulnerability to ligamentous injury. Because the vertebral bodies do not mature until children reach 8 or 9 years of age, severe shaking that causes forceful and repetitive flexion and extension of the cervical vertebrae places almost direct force on the spinal cord. The mismatch between the elasticity of the vertebral column and

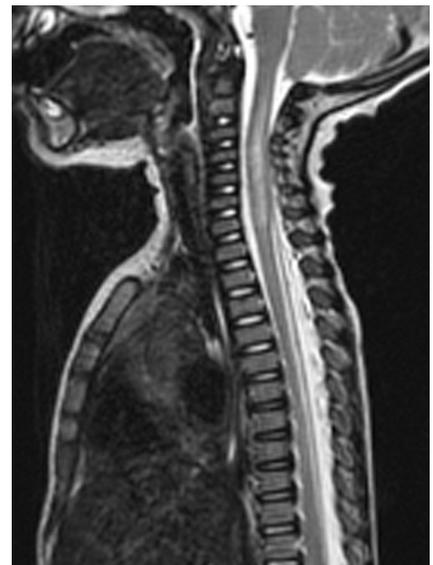


Figure 3. Sagittal T2-weighted MR image shows abnormal signal intensity and swelling extending from the cervicomedullary junction through T-2.

the spinal cord⁴ creates an opportunity for direct injury or for movement of the spinal cord. A child's spine allows as much as 2 cm of stretch whereas the spinal cord itself can withstand less than 0.25 cm of stretch before disruption ensues.⁷

Diagnosis

Shaken-baby syndrome is characterized by retinal hemorrhage, subdural

and/or subarachnoid hemorrhage, and minimal or no signs of external craniofacial trauma.¹ Our patient had severe neurologic impairment without evidence of intracranial or external craniofacial trauma on radiographs or CT.

Two criteria are fundamental to the diagnosis of shaken-baby syndrome: (1) a documented history of shaking of the infant and (2) no radiographic evidence of craniofacial trauma. Whether whiplash shaken-baby syndrome can occur without intracranial injury is debated. Authors have argued that traumatic cranial impact is a key component of whiplash shaken-baby syndrome. Our patient is interesting because he not only lacked an intracranial injury, he also lacked an identifiable radiographic abnormality on admission. Thus, the case also fits the category of SCIWORA.

Clinically, the patient had been in mild respiratory distress, which occurs in about 9% of patients with spinal trauma.³ The child's bilateral upper extremity paralysis and the location of the lesion in

the central spinal cord suggested that a central cord syndrome was responsible for the bilateral regions of motor and sensory loss.

MR imaging is the modality of choice for patients suspected of having SCIWORA. It allows evaluation of the spinal cord, ligaments, and discs—structures that cannot be evaluated adequately by radiography and CT. When no abnormalities or intracranial findings are apparent on plain radiographs and CT scans, MR imaging evaluation of the cervical cord may show abnormalities.

Conclusion

Our case demonstrates that children with traumatized necks, despite normal radiographic findings on plain radiographic films and without evidence of intracranial abnormalities, need further evaluation with MR imaging to rule out spinal cord injury suspected on clinical grounds. Given that early detection and care of this syndrome are vital to an op-

timistic prognosis, health-care teams must consider infant shaken-baby syndrome and SCIWORA in a child with clinical evidence of neurological pathology.

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