

Spinal cord injury without radiological abnormality (SCIWORA)

A diagnosis that is missed in unconscious children

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ABSTRACT

تحدث إصابات الحبل الشوكي عادة دون ظهور تغيرات في صور الأشعة للعمود الفقري العنقي عند الأطفال الصغار، وذلك لعدم إكمال نموه وحركته المفرطة. تمكن كل من الأشعة السينية والتصوير الطبقي للعمود الفقري للأطفال فاقد الوعي من إستبعاد الكسور وخلع الفقرات ولكن لاتبين إصابات الحبل الشوكي. نستعرض هنا حالة مرضية لطفلين أصيبا بفقدان الوعي مباشرة إثر حادث مروري وتعرضهم لإصابات عديدة. إستبعدت الأشعة العادية وجود كسور بالعمود الفقري العنقي، وأظهرت الأشعة المقطعية تغيرات بالحبل الشوكي لأحدهما، وأكد التصوير بالرنين المغناطيسي وجود إصابة شديدة بالحبل الشوكي. توفي الطفل الأول نتيجة إصابة شديدة بالدماغ والحبل الشوكي العنقي، وتحسنت حالة الطفل الثاني وكان يعاني فقط من ملتزمة براون - سيكارد. يجب أن تزداد معدلات توقع إصابة الحبل الشوكي للأطفال المصابين وفاقد الوعي، حتى في عدم وجود كسور بالأشعة. لذلك يجب تصوير العمود الفقري بالرنين المغناطيسي خاصة في حالة إعتمادهم على جهاز التنفس الصناعي بالعناية المركزة.

Spinal cord injury without radiographic abnormality (SCIWORA) usually occurs in the hypermobile, immature cervical spine of young children. In a comatose child, a normal spine x-ray, and CT scan exclude most cases of gross fracture and dislocation, but not SCIWORA. We present 2 children that sustained a polytrauma, which rendered each of them unconscious at the outset. In both, cervical spine x-ray excluded bony injuries, however, CT scan raised the suspicion of spinal cord injury in one, and MRI demonstrated significant cord injury in both. The first patient died from severe head and cervical spinal cord injury. The second patient recovered with mild Brown-Sequard syndrome. A high index of suspicion of SCIWORA is necessary in injured comatose children in whom movement of all limbs is not seen. Therefore, spine MRI should be considered if they are expected to remain ventilated for an unknown time.

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Spinal injury in pediatric trauma patients has received increasing attention over the last 2 decades as it may have catastrophic consequences if missed or not timely diagnosed. Spinal cord injury without radiographic abnormality (SCIWORA) is defined as the occurrence of a spinal cord injury despite normal plain radiographic studies. In addition, flexion/extension films and CT scans of the cervical spine may also be normal. There is wide range in reporting the incidence of SCIWORA, which reaches 70%. However, a true incidence is likely to be more than 20%.¹⁻³ In children with SCIWORA, MRI is a sensitive method in demonstrating soft tissue injuries, and traumatic disc prolapse, and in defining the extent of spinal cord injury.^{4,5} In children who are fully alert and oriented with no head injury or significant distraction injury, their cervical spine can be cleared clinically, and spine radiographic evaluation is unnecessary.⁶ In unconscious children, SCIWORA cannot be clinically determined, and only spinal ligamentous injury might be assessed with dynamic fluoroscopy in flexion and extension.⁷ However, this might cause a significant delay in diagnosing SCIWORA particularly for those children that will remain ventilated for a long period of time. We report a scenario of dealing with SCIWORA in 2 traumatized unconscious children, aiming to increase the familiarity among physicians to promptly diagnose SCIWORA and work to timely treat it and prevent further cord damage.

Case Report. Patient One. An 8-year-old boy was a pedestrian, involved in a road traffic accident. He sustained multiple injuries and was unconscious upon

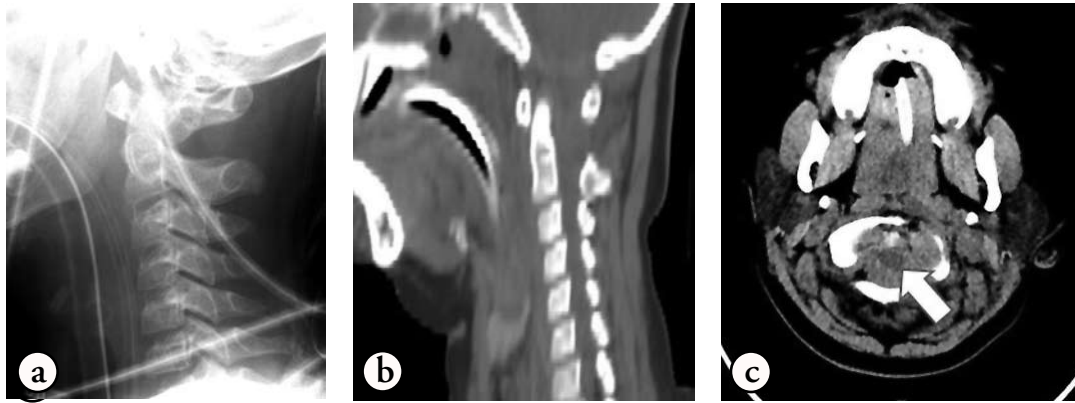


Figure 1 - a) Lateral cervical spine x-ray of the first case, and b) Sagittal reconstruction CT scan showing normal bone and alignment. c) Axial CT scan through C1 showed central hypodensity within the cord indicating spinal cord injury without radiographic abnormality.

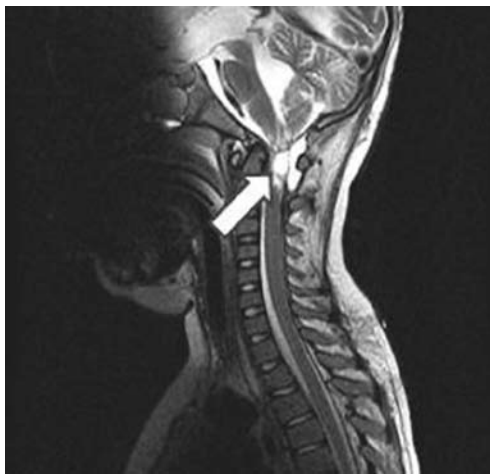


Figure 2 - Sagittal T2 weighted image MRI demonstrating severe injury of the upper cervical spinal cord and lower medulla with hemorrhage (arrow) within and outside the cord.

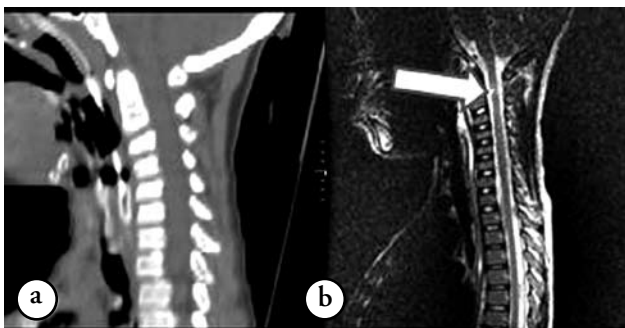


Figure 3 - (a) Sagittal reconstruction CT scan of the cervical spine of the second case showing normal bone and alignment. (b) Sagittal T2-weighted MR images of the cervical spine showing focal increased signal intensity in the upper cervical spinal cord (arrow), a finding that is consistent with edema or hemorrhage of the cord spinal cord injury without radiographic abnormality.

admission to the emergency room. He was resuscitated, and mechanically ventilated. Cervical spine x-rays excluded bony injuries, while CT scan showed no gross bony injuries but demonstrated some changes in the cervical spinal cord at the craniocervical junction (Figure 1). This was confirmed by MRI as severe cord injury (Figure 2). He suffered severe traumatic brain injury with uncontrollable elevation of intracranial pressure. Despite decompressive craniectomy, he failed to improve and expired a few days later.

Patient 2. The second patient was a 10-year-old boy, a non-restrained back-seat passenger was ejected out of the car in a high-speed accident when the car turned over. He was unconscious and not breathing. He received cardiopulmonary resuscitation immediately at the scene of the accident by a passing pediatrician, and was intubated upon arrival of the ambulance, then transferred to the hospital. Cranial and cervical CT scan were normal (Figure 3a). The child showed early signs of respiratory and neurologic recovery, and had an uneventful weaning off the ventilation, but neurological examination showed marked weakness involving right arm and leg with impaired sensation involving the left side of the body. An MRI was then indicated and showed an area of signal difference in the spinal cord at the level of C2, likely to be a contusion (Figure 3b). He gradually improved and recovered with a very mild form of Brown-Sequard syndrome.

Discussion. It is well known that children have a different injury profile from adults due to different anatomical and physiological features and exposure to different risk factors. The hypermobility of the young spine will allow stretching, without causing fracture, and would place the spinal cord at increased risk for stretching and disruptive injuries. This might explain the relatively low incidence of spinal column

injuries and the proportionately high incidence of SCIWORA.⁸⁻¹⁰ Pediatric spinal injuries are not uncommon. The overall incidence is not well known and may range from 1-11%. Pang¹ reported an estimated incidence of 5% of spinal injuries in children less than 16 years of age, at most major pediatric trauma centers, and found that this incidence was higher in the younger age group less than 10 years of age.¹ In alert children, the cervical spine can be cleared clinically, and those with neck pain or tenderness a 3-view cervical radiographic series (lateral, anteroposterior, and odontoid) is necessary. If pain and tenderness persist, despite normal plain film radiology, they should have flexion-extension views to exclude ligamentous injury. The procedure should be carried out in the presence of a doctor, and terminated if there is any increase in pain or abnormal neurologic sensation. Computerized tomography scanning is used to examine abnormal areas, and to inspect any regions that are difficult or impossible to visualize on the plain films.^{6,7} In unconscious ventilated children, it is difficult to elicit neurological signs suggestive of spinal cord injury. Our standard of practice to evaluate a potential cervical spine injury in an unconscious child sustained polytrauma is to perform CT scan of the cervical spine including craniocervical junction and cervicothoracic region as part of trauma survey. If no gross abnormalities are seen, and the child did not regain consciousness within 24 hours, MRI will then be considered once the child's general condition allows. It has recently replaced dynamic flexion-extension imaging of the cervical spine under fluoroscopic control, which allows for the assessment of pathological intersegmental motion consistent with ligamentous injury without fracture, but will not diagnose spinal cord injury.^{4,5,13,14} Later, Pang¹ suggested that abnormal somatosensory evoked potentials (SSEPs) are a strong indication for requesting a spine MRI. The first child was unconscious, and assessment of neurological function of the limbs was not possible. His plain cervical spine radiographs were normal and MRI was performed when the CT scan showed abnormal craniocervical area. It demonstrated severe injury at the upper cervical spinal cord and lower medulla, which contributed to the fatal prognosis of the injury. A normal cervical spine CT in this case would probably defer performing an MRI, until the time that it is possible to assess the child's limb movements, which certainly will lead to a delay in diagnosing spinal cord injury. Injuries in this area usually result in extreme instability at the craniocervical junction. Unfortunately, many of these injuries are fatal and their overall incidence is probably underreported. In the second child, the presence of abnormal neurologic signs was considered a strong indication for MRI. We suspected SCIWORA, or compressive lesion of the cord or roots or ligamentous

disruption that might warrant surgical intervention. If this child did not regain his consciousness within 24 hours, it would not be possible to timely diagnose SCIWORA, which appeared in the MRI as subtle and tiny however, caused significant neurological symptoms. This could be explained by the relatively greater inherent mobility in the immature axial skeleton, combined with ligamentous laxity or disruption, and renders the spinal cord vulnerable to damage in high-energy trauma. In the absence of osseous injury on plain radiographs and CT scan, MRI demonstrated the abnormality in this case. It is important to know the extent of spinal cord injury in a comatose injured child by obtaining an MRI of the cervical spine in the early stages of management, and not to wait until neurological assessment is possible. The MRI appearance of the spinal cord is predictive of neurological outcome in children with SCIWORA. Absence of signal change within the cord is usually associated with an excellent outcome. Signal change consistent with edema or micro hemorrhages, but not hematomyelia, is associated with significant improvement of neurological function over time, as occurred with the second case, which showed rapid neurological improvement. The presence of frank hematomyelia or cord disruption is associated with a severe, permanent neurological injury.¹⁵

In conclusion, SCIWORA must be excluded in all unconscious injured children in whom movement of all limbs is not seen and have apparently normal radiographs, especially if the child does not regain consciousness within 24 hours. An MRI is a sensitive method of demonstrating ligamentous damage, and defining the extent of spinal cord injury. It should replace dynamic flexion-extension imaging, whenever available, in the unconscious patient. The appearance of abnormalities in the spinal MRI will warrant the treating physician to provide early treatment and have prognostic information regarding neurological outcome in the presence of SCIWORA.

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