SCIWORA – in Children with Associated Head Injury: Role of MRI

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Confirmation of spinal cord injury is difficult in comatosed or obtunded patients. This becomes even more difficult in children where spinal cord injury can occur without obvious vertebral column disruption. Therefore an advanced diagnostic method for the evaluation of suspected spinal cord injury is desirable. We conducted a prospective study in which Magnetic Resonance Imaging was used to assess posttraumatic spinal cord injury in the comatosed or obtunded paediatric patients. Early limited (sagittal T1-T2 Weighted) MR Imaging was performed to delineate and differentiate the diagnosis of SCIWORA in seven children with head injury and possible spinal injuries. Patients were excluded from the study if they had an obvious spine injury (bony and /or ligamentous) identified on the initial radiographic studies. Obtaining early sagittal T1-T4 weighted MR Imaging is a safe strategy for the identification of this non-apparent spinal cord injury in obtunded or comatose trauma paediatric patients. In all seven patients except one the MRI findings correlated well with our clinical findings.
Key words: Spinal injury, limb weakness, normal x-rays

SCIWORA (Spinal Cord Injury Without Radiological Abnormality) has been well described as a paediatric spinal cord injury by Pang and Dickman. This acronum was first coined by Pang in 1982 at Pittsburgh. It occurs almost exclusively in the paediatric age group – less than 8 years old.

By definition, children with SCIWORA have evidence of traumatic myelopathy without vertebral subluxation or fracture on plain film or CT scan.

The incidence of SCIWORA is reported to be between 16-21% (32% in those under 8 years) (PANG) of all spinal or vertebral column injuries.

Pedestrian related RTA (Road Traffic Accident) and falls are the most frequent cause of injury.

Anatomical and biomechanical basis of SCIWORA

The main differences between adult and paediatric spines have been well documented. The combination of relatively large head on tope of a largely cartilaginous spine with shallow facet joints, lax ligaments and immature joint of Lusheka contributes to produce a hypermobile spine. This cause inherent elasticity with self reducing significant intersegment displacement when subjected to flexion, extension and distraction forces. The spinal cord is therefore vulnerable to injury and ischaemia even though the vertebral column is spared from radiologically detectable disruption. Spinal cord injury in children is unique in many respects and possesses distinctive characteristics compared to spinal injury in adults.

The development of the paediatric vertebral column is a continuous, dynamic process characterised by alterations in the geometric configuration of vertebrae, development of ossification causing closure of epiphyseal plates, alternations in ligamentous and soft tissue characteristics, and changes in osseous strength, integrity, shape and size. These continuous developmental processes create different patterns of susceptibility to injury among children compared to adults. As the biomechanical and anatomical features of the spine begin to approach the adult patterns between the ages of 8 and 10 so do the type of injuries. However, the adult morphological characteristics are not fully manifested until after the age of 15 years.

The vertebral bodies in the paediatric spine are wedge shaped and the vertebrae are primarily cartilaginous. The vertebrae will continue to grow during adolescence. The facets have a relatively horizontal orientation. They become more vertical and ossify between the ages of 7 and 10 years. Until then, they contribute little to vertebral column stability. The head is large with respect to the neck and torso. The paraspinal muscles are less developed especially in the neonate. The vertebral ligaments and soft tissues have greater elasticity than in adults. These features combine to create hypermobility and perdisposition to SCIWORA in children with spinal injuries.

Dignosis

The diagnosis is usually clinical. A problem however arises in defining the site of primary pathology i.e., spinal cord or brain when spinal cord injury occurs in association with head injury, particularly with hemicord injury. Brain injury may obscure SCI (Spinal cord Injury) signs, particularly in children, as vertebral bony changes are often absent.

This dilemma can be partly addressed by identifying signs and symptoms that may suggest unsuspected SCI when brain injury dominates the clinical picture.

1. Disparity of reflexes and power between arms and legs.
2. Diaphragmatic breathing.
3. Hypotension with bradycardia.
4. Neck pain with reduced movement.
5. Warm shock

At times there may be no physical signs and it may be difficult to assess the patient. The physical signs may have resolved by the time of examination in some cases. Spinal cord injury may therefore be missed with grave consequences.

The advent of MRI has revolutionised the investigation of suspected cervical spine injury. MRI can be critical in differentiating head injury from spinal cord injury in a patient presenting with hemipresis, head injury and suspected cervical spine injury.

We performed a prospective study in order to delineate and the diagnosis of SCIWORA in patients with head and possible spinal injuries. We found six patients with positive MRI findings and correlated their radiological findings with our clinical findings.

Clinical materials

We had seven patients who presented with a combination of head and spine injuries over the three years period. Patient characteristics are given in Table 1. The average age was 4.7 eyars (range 2.5 to 9 years). There were four females and three males. All were mother vehicle accidents and pediastrians were the victims. It was not possible to comment with any degree of certainty on the biomechanical mechanism of injury. All had associated head injuries with Glasgow Coma Scale on admission and six hours after resuscitation ranging between 7/15 to 13/15. One patient required intubation and ventilation.

All patients were assessed neurologically twice daily by attending neurosurgeon. All had cervical spine. X-rays, skull x-rays and CT head on admission. When SCIWORA was suspected MRI was performed within 5 days except one. The patients were treated in Holter Traction until their pain subsided. At this point a lateral flexion x-rays was performed. Following this the patients were put in a firm collar for a further month. At this stage a repeat lateral flexion view was performed, which if normal, the collar was removed.

Results

Four patients who presented with hemiparesis and associated head injury experienced neck pain either with limited neck rotation or flexion. The two patients who presented with paraparesis had discrepancy between upper and lower limb reflexes. One of them had impaired sensations.

No	Age	Sex	Mechanism of injury	Associated Head Injury	Clinical Signs	MRI
1	9Y2M	F	RTA	GCS 13/15	Paraparesis	Increased signal intensity T_9
2	3Y5M	M	RTA	GCS 13/15	Rt. Hemiparesis	C_2-C_4 enlarged
3	4Y	M	RTA	GCS 11/15	Lt. Hemiparesis U/L 0/5 L/L 3/5	Increased T_2 intensity
4	2Y6M	M	RTA	GCS 7/15	Parapaeresis	Increased signal lower cervical (C_8-T_1)
5	6Y	M	RTA	GCS 12/15 Rapid recovery	Lt. Hemiparesis decreased chest movement	Swollen cord (oedema) in the cervical area
6	3Y6M	F	RTA	GCS 13/15 Rapid recovery	Brown sequard syndrome	Increased T_2 signal in high thoracic area
7	4Y6M	F	RTA	GCS 12/15 Rapid recovery at 48 hours	Rt. Hemiparesis decreased chest movement U/L 1/5 L/L 3/5	Increased T2 signal in high cervical rea

RTA (Road Traffic Accident, U/L (Upper limb), L/L (Lower limb)

MRI scan was diagnostic in all but one in which there were no specific changes seen in cord except oedema. This patient had rapid recovery afterwards.

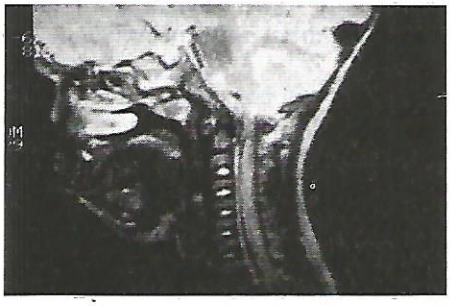

Fig. 1a: Sagital MRI showing high signal in high cervical cord and PLL

Fig. 1b: Sagital MRI showing high signal L1-2 area

Fig 1c: Sagital MI showing high signal in mid thoracic area

Discussion

SCIWORA had been a well recognised entity for many years. The overall incidence of spinal column injury in children is low due to many factors, including ligamentous laxity, wedge shaped vertebrae and shallow facet joints. This allows a greater flexibility of the spinal column surrounding the spinal cord in children. Therefore, as a result, degrees of trauma, which may cause fracture and dislocation of the more rigid spine of the adult may not result in fracture in children. Unfortunately, with severe trauma, this relative flexibility may result in sever underlying spinal cord damage potentially undetectable on the routine radiological survey which may be normal.

Presence of head injury and impairment of consciousness can make the diagnosis more difficult. Coexisting spinal cord injury must be considered during initial evaluation of the multiply injured child even in the presence of normal spine radiograph and CT scan. However, the diagnosis of SCI may be difficult to determine clinically, particularly when the patient presents with severed cognitive impairment.

Maintaining stability of the spine can be critical to prevent further loss of neurologic function. Delay in diagnosis can have grave consequences. Although certain signs and symptoms may suggest unsuspected SCI in the presence of brain injury, physical signs may be difficult to elicit or may not be there. If and when they appear it may be too late to do anything.

In this population of patients it is clear that a safe, easy method is required to evaluate the spine. We have found that sagittal T_1 and T_2 MRI in this situation is both safe and useful for diagnosis of SCI.

Conclusion

Sagittal T1/T2 weighted MRI appears to be a safe and reliable method for evaluation the spine in children with head injury and suspected SCI. The nursing and medical care is thereby facilitated for patients in whom occult injury to the spine is ruled out and for those attendant precautions are unnecessary.

We also conclude:

a) The common practice in adults to relax or remove appliances to maintain full spinal immobilisation once normal spinal films have been obtained should not be the case in children under 8 years of age.

b) In the unconsious child with suspected SCI full spinal immobilisation should be achieved immediately and this should not be removed despite normal radiographs until the child can be assessed or T1/T2 weighted sagittal MRI has been performed.

c) In the conscious and recovering child in whom spinal injury is thought to be a possibility, repeated neurological examination should be performed during the hospitalised period, and a high index of suspicion of spinal injury should be continued.

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