

MULTIPLE NONCONTIGUOUS INJURIES OF THE SPINE IN A CHILD :
ATLANTOOCIPITAL DISLOCATION AND SEAT-BELT INJURY
OF THE LUMBAR SPINE

R. VEDANTAM, A. H. CRAWFORD

Multiple noncontiguous injuries of nonadjoining regions of the spine in children are rare. Such injuries can be overlooked as the neurological deficit caused by one injury can be masked by the other. The combination of atlantooccipital dislocation and a seat-belt injury of the spine in children is rare. We describe an unusual case of atlantooccipital dislocation in combination with a seat-belt injury of the lumbar spine in a surviving child. Early halo-vest immobilization was an effective treatment in this patient. Although survival with atlantooccipital injuries is becoming common, severe and persistent neurological deficits can result in high morbidity. A brief description of the pathomechanics, diagnosis and treatment of the atlantooccipital dislocation and lumbar seat-belt injury is given.

Keywords : multiple noncontiguous injuries of spine ; atlantooccipital dislocation ; seat-belt injury.

Mots-clés : lésions traumatiques multiples non contigues ; colonne ; luxation atlanto-occipitale ; ceinture de sécurité.

INTRODUCTION

Multiple noncontiguous injuries of the spinal column are injuries to the vertebral column at more than one site, with these sites being separated by an area of normal spine. These injuries usually involve adjoining anatomic regions of the spine (4). Multiple injuries of the spine in children commonly involve contiguous regions of the spine because the force of the injury is distributed over multiple segments of the spine owing to the increased elasticity of the pediatric spine (3). Multiple noncontiguous injuries of the spine in children are rare and can be easily overlooked, especially in cases where neurological damage caused by one injury

is concealed by the other. Although both atlantooccipital injury and seat-belt injury of the spine are recognized individually in children, the combination is rare. A review of published reports of noncontiguous spine injuries in the English-language literature revealed only 2 cases of cervical spine injury in association with a lumbar spine injury in patients less than 18 years old (1, 6). We report an unusual case of multiple noncontiguous injuries of nonadjoining regions of the spinal column in a child : a traumatic atlantooccipital dislocation (AOD) and a lumbar seat-belt injury.

CASE REPORT

A 5-year-old white male who was a restrained back-seat passenger was involved in a head-on collision between two vehicles traveling at 55 mph. The patient was thrown forward by the impact of the collision. The patient was found to be unresponsive, cyanotic, and apneic at the scene of the accident. After resuscitation, the patient was immobilized on a backboard with a cervical collar and head restraints in place and transported to the hospital. On his arrival, the Glasgow Coma Scale was 3, and the patient showed no spontaneous movement or any response to deep pain. Pupils were reactive to light and the gaze was conjugate. Other findings on clinical examination included presence of ecchymoses across the lower abdomen

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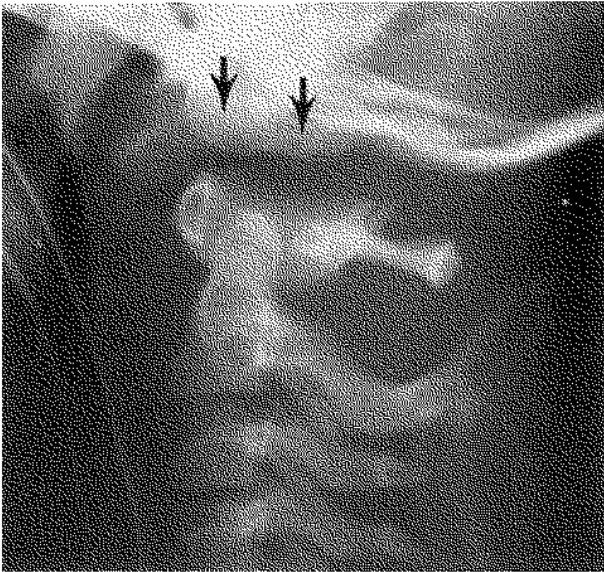


Fig. 1. — Initial radiograph of the cervical spine showing separation of the occipital condyle and the atlas.

(seat-belt sign) and diminished breath sounds on the left side of the chest. The patient was hemodynamically stable. Subsequent examination revealed normal function of the cranial nerves. Initial radiographs of the cervical spine showed an abnormal separation between the occipital condyle and the atlas (fig. 1) indicating atlanto-occipital dislocation (AOD). Radiographs of the lumbar spine showed a seat-belt injury consisting of a ligamentous injury through the posterior elements of L3 with fracture of the inferior facets of L3 and anterior compression of the L4 vertebra (fig. 2). CT-scan and MRI of the skull and the cervical spine done on the day of admission showed presence of subarachnoid blood in the interpeduncular cistern and hemorrhage in the left posterior soft tissues between C1 and C2 with spinal cord edema and swelling from the foramen magnum to C3. The vertebral arteries were intact and showed normal flow. A CT-scan of the abdomen and pelvis revealed free pelvic fluid with evidence of mesenteric injury.

Initial treatment for the AOD was started in the emergency department and consisted of halo traction with 2 pounds' weight. Halo traction tended to produce distraction at the occiput-C1

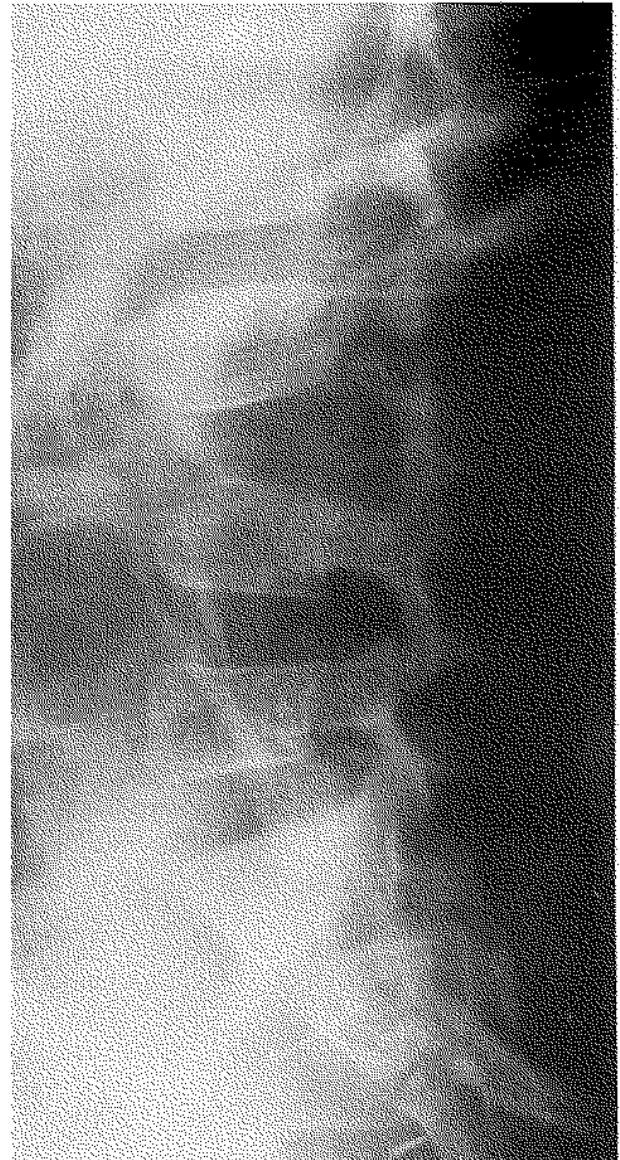


Fig. 2. — Initial radiograph of the lumbar spine showing anterior compression fracture of the L4 vertebra and disruption of the posterior elements of L3.

junction. Hence, traction was abandoned in favor of immobilization in a halo vest. Immobilization of the lumbar spine injury was achieved by extending the vest to incorporate the iliac crest, prior to rehabilitation. Initial management of the patient also consisted of a tracheostomy for ventilatory support, a ventriculostomy to monitor intracranial pressure and an exploratory

laparotomy for repair of the disruption of the mid-jejunum and a serosal tear of the cecum. The patient was discharged home on ventilator support.

Flexion-extension lateral cervical spine views done 3 months after injury showed no instability at the occiput-C1 junction. At the 9-mo. follow-up examination, there was no neurologic recovery and the radiographs of the cervical spine demonstrated a stable spine (fig. 3). The lumbar spine was also noted to be stable on radiographic evaluation. Eighteen months after the injury, the patient has complete quadriplegia below the C3 level. He continues to be on ventilator support with in-home nursing care.



Fig. 3. — Nine months after the injury, the radiograph of the cervical spine shows a stable spine.

DISCUSSION

It would appear that multiple noncontiguous injuries of the spine are caused by more than one force on the spine (4). In the case presented, the

patient was a restrained back seat passenger in a vehicle that was involved in a head-on collision, and the sudden deceleration force was responsible for the spinal injuries occurring at two different locations of the spinal column. The AOD was caused by the deceleration force acting upon an unrestrained head and neck. With the pelvis being immobilized by the lap belt, the deceleration force resulted in flexion of the trunk, thereby producing distraction forces in the thoracolumbar spine. This resulted in a compression fracture of the L4 vertebra with fracture through the posterior elements of L3.

Although several mechanisms of causation of AOD have been described, it is probable that AOD results from a combination of dynamic forces that result in hyperextension, lateral flexion and hyperflexion (7). Traynelis *et al.* (9) have described three different types of AOD. Type I AOD is anterior dislocation of the cranium with respect to the atlas, type II is longitudinal distraction of the cranium without any anterior or posterior displacement, and type III is posterior displacement of the occiput in relation to the atlas. Type II is the most common form of AOD seen in children, perhaps owing to the relatively lax ligaments of the atlantooccipital joint (9). Early diagnosis of this injury can usually be made from the lateral cervical spine radiograph but can be missed if the findings are subtle (7). The diagnosis of Type II AOD can be made if the distance between the occipital condyle and the superior facet of the atlas is more than 5 mm (5). In our case, the initial lateral radiograph of the cervical spine was diagnostic of the AOD. An MR imaging was done to evaluate the extent of spinal cord and cerebral damage and to delineate the disruption of the ligaments at the occipitoatlantoaxial complex. Although the usual outcome after traumatic AOD is death due to transection of the brain stem, survival is being reported with increasing frequency, perhaps owing to improvements in initial resuscitation, safe transportation and a high index of suspicion (7, 9). Among patients who survive traumatic AOD, severe and persistent neurological deficits contribute to the morbidity. Quadriplegia or quadriparesis is the most common finding in survivors. Cranial nerve palsies usually accompany

atlantooccipital dislocation, and the sixth nerve is most frequently involved. Vertebral artery injuries have also been reported and have been implicated in the causation of the neurological deficits (2).

The use of axial traction, even initially, as a means of spinal immobilization in children with AOD should be considered with caution. Even minimal traction weight can result in overdistraction at the occiput-C1 junction with a potential risk of further neurological damage. Early halo-vest immobilization was an effective form of treatment in our patient and should be considered as the first line of treatment. Should instability persist after a 12-week period of immobilization, surgical fusion is indicated. Immediate surgical fusion has been advocated by some authors, as there is a possibility of persistent instability even after prolonged immobilization (7).

Although fractures of the lumbar spine due to seat belts are well recognized in adolescents and adults, there are few reports of such injuries in children for whom the adult lap belts may provide less than optimal protection (8). Rumball *et al.* (8) identified four distinct patterns of lap belt injury in children depending on the extent of ligamentous disruption and the pattern of fracture. In young children, because of the immature iliac crests, the lap belt cannot be positioned properly over the hips. This results in the belt riding up over the abdomen resulting in abdominal injuries, as was the case in our patient; assessment of the abdominal signs may be difficult in view of the associated abdominal wall bruising and the spinal injury. Abdominal CT-scan and peritoneal lavage should be considered if there is a suspicion of an intraabdominal injury. Seat-belt injuries of the spine in children can usually be treated nonoperatively (8).

Although multiple noncontiguous injuries of nonadjacent regions of the spine are uncommon in children, a detailed history and neurological examination as well as a careful reconstruction of the injury scene could provide clues to the possibility of this injury. If the neurological damage does not correlate with the level of the spine injury, the possibility of a second spinal injury including a spinal cord injury without radiological abnormality (SCIWORA) should be considered. The

principles of treatment of these injuries are the same as for isolated injuries of the spine.

REFERENCES

1. Beldekos A., Korres D. S., Nikolakakos G. A Chance's fracture in a double level fracture of the spine. *Injury*, 1981, 13, 34-36.
2. Evarts C. M. Traumatic occipito-atlantal dislocation: Report of a case with survival. *J. Bone Joint Surg.*, 1970, 52-A, 1653-1660.
3. Hadley M. N., Zabranski J. M., Browner C. M., ReKate H., Sonntag V. K. H. Pediatric spinal trauma: Review of 122 cases of spinal cord and vertebral column injuries. *J. Neurosurg.*, 1988, 68, 18-24.
4. Henderson R. L., Reid D. C., Saboe L.A. Multiple noncontiguous spine fractures. *Spine*, 1991, 16, 128-131.
5. Kaufman R. A., Carroll D. C., Buncher C. R. Atlanto-occipital junction: Standards for measurement in normal children. *Am. J. Neuroradiol.*, 1987, 8, 995-999.
6. Kewalramani L. S., Taylor R. G. Multiple noncontiguous injuries to the spine. *Acta Orthop. Scand.*, 1976, 47, 52-58.
7. Papadopoulos S. M., Dickman C. A., Sonntag V. K. H., ReKate H. L., Spetzler R. F. Traumatic atlantooccipital dislocation with survival. *Neurosurgery*, 1991, 28, 574-579.
8. Rumball K., Jarvis J. Seat-belt injuries of the spine in young children. *J. Bone Joint Surg.*, 1992, 74-B, 571-574.
9. Traynelis V. C., Marano G. D., Dunker R. O., Kaufman H. H. Traumatic atlantooccipital dislocation: Case report. *J. Neurosurg.*, 1986, 65, 863-870.

SAMENVATTING

R. VEDANTAM, A. H. CRAWFORD. Multiple verspreide traumatische letsels van de wervelkolom bij een kind: atlanto-occipitale luxatie en veiligheidsgordel letsel van de lumbale wervelkolom.

Multiple verspreide traumatische letsels van de wervelkolom bij het kind zijn zeldzaam. Soortgelijke letsels kunnen miskend zijn wanneer sommige neurologische uitvalsverschijnselen anderen maskeren. De combinatie van 1 atlanto-occipitale dislocatie met een veiligheidsgordel letsel van de lumbale wervelkolom bij kinderen is uitzonderlijk.

De auteurs rapporteren een ongewoon geval van atlanto-occipitale luxatie gecombineerd met een veiligheidsgordel letsel van de lumbale wervelkolom bij een kind die het trauma overleefd heeft. Een vroegtijdige haloimmobilisatie blijkt een efficiënte behandeling. Ofschon een overleving na atlanto-occipitale trauma's

frekwenter wordt, kunnen steeds ernstige en irreversibele neurologische uitvalsverschijnselen aanleiding geven tot een belangrijke morbiditeit. Korte beschrijving van de patho-mechanica, van de diagnostiek en van de behandeling van atlanto-occipitale luxaties en lumbale veiligheidsgordel letsels.

RÉSUMÉ

R. VEDANTAM, A. H. CRAWFORD. Lésions traumatiques multiples non-contiguës du rachis chez l'enfant : luxation occipito-atlantoïdienne et lésion de la colonne lombaire par ceinture de sécurité.

Les lésions multiples non-contiguës et disséminées de la colonne vertébrale chez l'enfant sont rares. Pareilles

lésions peuvent être méconnues lorsque les signes neurologiques provoqués par une lésion en masquent d'autres. La combinaison d'une luxation occipito-atlantoïdienne et d'une lésion de la colonne lombaire par ceinture de sécurité chez l'enfant est exceptionnelle. Les auteurs en décrivent un cas inhabituel chez un enfant qui survécut. L'immobilisation précoce par halo fut un traitement efficace chez ce blessé. Quoique les cas de survie après lésions occipito-atlantoïdiennes deviennent plus fréquents, les séquelles neurologiques peuvent être à l'origine d'une très importante morbidité. Les auteurs passent en revue la patho-mécanique, le diagnostic et le traitement des luxations occipito-atlantoïdiennes et des lésions de la colonne lombaire par ceinture de sécurité.