Initially overseen vertebral body luxation: diagnosed by dynamic fluoroscopy due to delayed dysphagia

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Abstract This study relates to the case report of a neurologically intact 13-year-old boy with unrecognized traumatic bipedicular vertebral fracture. He was diagnosed complete vertebral body luxation 1 day later by dynamic fluoroscopy, then successfully treated with surgery that resulted in total recovery. The delayed diagnosis highlights the importance of detailed initial clinical and radiology examinations, even when overt symptoms as diagnostic indicators of severe neurological sequelae expected in similar traumatic vertebral fractures are lacking. A 13-year-old boy, who met with a minor bicycle accident, was presented with two small forehead lacerations but without pain or clinical neurological symptoms for radiological examination, which showed no abnormalities. The following day, however, the patient complained about dysphagia and underwent dynamic fluoroscopy for the assessment of deglutition that revealed a total block of contrast medium. Computer tomography (CT) of the cervicothoracic junction showed a bipedicular thoracic vertebral fracture and a hooked vertebral body luxation causing mechanical dysphagia but, surprisingly, without compression of the spinal cord. The patient fully recovered after carefully carried out protracted distension and orthopaedic surgery with vertebral fusion. One year after surgery, the patient had clinically resumed normal function, and CT showed a sufficient vertebral bony consolidation with anatomical

alignment. This case exemplifies the importance of careful initial clinical examination and spinal CT after accidents encompassing an increased risk of spinal fractures, even if neurologically unapparent.

Keywords Spinal fracture · Unrecognized · Dysphagia · Fluoroscopy · Vertebral fusion

Introduction

Unrecognized acute traumatic spinal fractures in children and infants are not as uncommon as generally believed. The most common factors predisposing to radiological misdiagnosis are unfamiliarity with spinal anatomy, failure to recognize normal variants seen during growth and development, and suboptimal conventional film techniques [1, 3, 5, 7]. A common reason for clinical misdiagnosis of spinal injuries is an insufficient and unmindful initial clinical examination. The incidence of acute pediatric spine fractures is reported to be 1–3% of all spinal injuries, and up to 14% of patients misdiagnosed at initial emergency room imaging suffer from neurological sequelae that are not apparent at initial evaluation [2, 6, 8, 11]. Most spinal fractures are due to a flexion-compression mechanism producing comminute fractures of vertebral bodies or spondylolysis, both often accompanied by neurological symptoms varying from minor to very severe [13].

We present the case in which the absence of such neurological symptoms after a minor bicycling accident resulted in the initial failure of clinical and radiological diagnostic procedures to identify a vertebral fracture with complete luxation of thoracic vertebral bodies. This fracture was diagnosed by dynamic fluoroscopy 1 day later when the patient presented clear signs of dysphagia.

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Case report

One hour after a minor bicycling accident, a neurologically intact 13-year-old boy was presented at the Radiology department for routine radiological examination. Clinical anamnesis revealed neither loss of consciousness nor amnesia. He was fully orientated, capable of describing the cause and mechanism of the accident, and experienced no change in normal gait pattern. He was presented with two small forehead lacerations that were sutured with two stitches. Prior physical examination was reported unremarkable, and conventional radiographs of the skull, chest and thoracic spine (Fig. 1) were read as normal. Except for the pain from the forehead lacerations, the patient did not report any physical limitation or thoracic or spinal pain. Neurological examination revealed slightly asymmetric tendon reflexes and thus a native cerebral computer tomography (CT) to exclude cranial fracture or intracerebral blood was performed and found to be inconspicuous. Routine clinical considerations after possible cerebral concussion required overnight observation at the Pediatrics Clinic, and a follow-up native cerebral control CT the next morning was again unremarkable. However, when interviewed by the radiologist about his general condition, the patient complained about dysphagia.

Fig. 1 Initial plain X-rays of the thoracic spine showing that the dislocated fracture was adelomorphous due to over-projection of the clavicles, scapulae, and upper limbs on the lateral view (*right*), and further limited by the fact that both Th1 and Th2 interleaved on the anterior–posterior view (*left*)

Thereafter, the patient underwent dynamic fluoroscopy with isoosmolar contrast medium (iodixanol, Visipaque 270 mgI/ml, Amersham Health, Norway) to assess deglutition, which revealed a total block of contrast medium below the superior esophageal sphincter, but no extravasate (Fig. 2). Subsequently, still neurologically intact, he underwent native CT of the cervicothoracic junction, which showed a bipedicular fracture of the arch of the 2nd thoracic vertebral bone (Th2) and a hooked complete luxation of Th1 and Th2 where Th2 fully dislocated ventrally to the body of Th1. The intervertebral disc remained on the ground plate of Th1. Above Th1 and below Th2, the vertebral alignment remained anatomical. This condition caused mechanical dysphagia without compression of the spinal cord (Fig. 3). According to the Magerl classification, the patient presented with a B.3.2 injury [10]. Fortunately, no bony fragments were protruding into the spinal canal and there were no signs of spinal cord damage (Fig. 4). The patient was immediately fitted with a Philadelphia cervical collar. Neurological examination of the upper and lower limbs revealed no hypoesthesia, and possible deficit in muscular strength was not evaluated.

To exclude perivertebral vascular damage, color Doppler sonography of the main cervical and vertebral arteries and adjacent veins was performed and showed no vascular pathology. The patient was placed in pediatric intensive care, received a gastrogavage for endoluminal nutrition, and was closely monitored.

There were two options for surgical treatment: (1) immediate open surgical reduction or (2) a carefully protracted extension followed by surgical intervention. Since the patient neither showed clinical nor neurological deficits and dysphagia could be managed with gastrogavage, the potential risk of obstructing the spinal canal with protruding remnants of the vertebral disc during immediate open reduction was decisive for the second treatment strategy. Direct cranial traction was applied (halo Crutchfield extension traction of initially 2.5 kg) in addition to medical therapy with intravenous mannitol and methylprednisolone for 24 h to prevent possible development of spinal cord edema. The neurological picture remained unchanged and after 13 days of carefully protracted cervicothoracic extension with increasing weight (initially 2.5–12 kg after 9 days), Th2 was successfully placed ventrally below the ground plate of Th1 (Fig. 5). Dysphagia had concurrently improved, gastrogavage was removed, and the patient could eat normally. The intervertebral disc detached from Th1, made a reposition of Th1 on the slab of Th2 impossible. However, the anatomical positions of the vertebral bodies were eligible for the first of two reconstructive and stabilizing orthopaedic surgeries. The patient and his parents were informed about all possible complications of surgery and they gave their informed written consent.

Fig. 2 Dynamic fluoroscopy to assess deglutition showing a total block of contrast medium approximately 1.5 cm below the esophageal sphincter

Fig. 3 Three-dimensional reconstruction of a native CT of the cervicothoracic junction revealing a bipedicular fracture of Th2 and a hooked luxation of Th1 and Th2

Fig. 4 Sagittal CT reconstruction showing a bipedicular fracture of the arch of Th2 and a hooked luxation with Th1, Th2 dislocated ventral to Th1. Of note, the alignment above Th1 and below Th2 is intact. Remains of the contrast medium from dynamic fluoroscopy can be seen ventral of the vertebral spine

Fig. 5 Sagittal native CT reconstructions of the cervicothoracic junction showing the progress of carefully protracted cranial traction on days 1 (a), 2 (b), 5 (c), and 9 (d)

Briefly, the first surgical procedure was intended to reposition of Th1 and Th2 and achieve ventral vertebral body fusion. The patient was placed in supine position. All initial surgical procedures were done via an anteromedial approach. The praevertebral soft tissues showed scarring adhesions that had to be removed. Under continued halo traction and observation of neurological potentials, the remnants of the vertebral disc between Th1 and Th2 were removed. A dorsally located small bony fragment was also removed. Th2 was reentered into its original anatomical position and pelvic autologous corticospinous bone graft (from the right iliac hip bone) was placed between Th1 and Th2 before halo traction was released. Ventral fusion of Th1 and Th2 (two screws, respectively) with a titanium-H-plate was installed. Throughout the procedure, both afferent and efferent neurological potentials were unremarkable and a bolus of 40 mg of dexamethasone was given intravenously. Postoperatively, the patient was fitted with a Yalebrace.

The second stabilizing orthopaedic surgical operation was scheduled 13 days thereafter. The patient was placed in a prone position and the cervicothoracic junction was approached posteromedially. Titanium screws were inserted transpedicularly into Th1, Th3, and Th4 and fixed with two adapted paraspinous titanium microplates. Again, an autologous corticospinous bone graft was fitted between the spinous processes of Th1 to Th4. The patient was again fitted with a Yalebrace.

Fig. 6 Control CT after 1 year showing sufficient ventral and dorsal bony consolidation and normal vertebral alignment but a calcification of the vertebral disc between the 7th cervical and the 1st thoracic vertebra

Results

In this case, transient pareses of the recurrent laryngeal nerve required gastrogavage, but resolved by the 4th postoperative day. Two weeks after the second orthopaedic operation, radiological and orthopaedic examination showed that mobilization without further Yalebrace was possible. The patient had no pain or fever and was released from the hospital 48 days after his accident with detailed instructions and a schedule for physical rehabilitation.

After 1 year from the accident date and 10 months of physical rehabilitation, CT showed both ventral and dorsal fusion with sufficient bony consolidation (Fig. 6). However, the follow-up CT examination showed that the anterior plate was touching the ventral portion of the intervertebral disc between the 7th cervical vertebra and Th1, causing a calcification of the fibrous annulus.

Discussion

In the clinical routine of acute emergency responses, radiological evaluations are of major importance. Under certain conditions, however, radiological examinations of the thoracic or lumbar spine can be forgone if patients do not fulfill one or more of the five following criterion of the National Emergency X-Radiography Utilization Study (NEXUS): (1) a focal neurological deficit, (2) posterior

mid-line cervical tenderness, (3) intoxication, (4) a distraction painful injury, and (5) altered level of alertness [9]. In addition, the results of a sub-analysis of the NEXUS population especially focusing on spine injuries in children verified the NEXUS criterion in children aiming to reduce the rate of unnecessary radiography [14]. All other situations require radiological examination [12]. In patients with injuries after accidents that have a low risk for spinal fractures [4], the decision whether patients should undergo conventional X-ray or CT examination is mostly based on subjective first clinical impressions and initial clinical examinations by the referring physician. Of note, Blackmore et al. showed that in terms of socioeconomic cost-effectiveness, CT examination is seldom justified in patients after accidents at low risk for spinal fractures or a secondary development of neurological disorders [4].

In our patient, conventional radiological examinations were performed despite the fact that none of the above-mentioned NEXUS criteria against a radiological examination were fulfilled. However, in contrast to CT, plain radiographs of the spine are often compromised by technical limitations and thus can result in an increased risk of misdiagnosis. Detailed knowledge of the physiological vertebral anatomy and normal variations as well as of typical regions that are known to carry an increased risk for fractures in certain accident mechanisms is essential. The reasons for initial misdiagnosis in our case were multifaceted: in addition to his relatively small forehead lacerations, the patient (1) was neurologically unremarkable, (2) demonstrated normal gait, (3) showed no cervical pain or limitations of motility, and (4) had no other signs of physical injury. It should be mentioned, however, that the initial clinical examination must have been insufficient and a full man scan including palpation and careful exploration of the whole spine and the spinous process by the referring physician might not have been performed adequately and thus has biased future diagnostic radiology strategies. Moreover, on the plain X-rays, the region of the dislocated fracture was adelomorphous due to over-projection of the clavicles, scapulae, and upper limbs on the lateral view and was further limited by the fact that both Th1 and Th2 interleaved on the anterior–posterior view (Fig. 1).

In addition to a more precise clinical examination, an initial cervicothoracic CT examination in this patient would have accelerated the diagnosis and decreased the risk for a serious, and possibly even fatal, spinal cord injury while the boy was under normal pediatric overnight observation. Fortunately, the hooked luxation of Th1 and Th2 remained stable overnight and no bony fragments protruded into the spinal canal. However, we are not proposing a general initial perusal of CT scans to every

bicycling accident, but in a considerable number of cases of doubt about upper thoracic spine injuries, a CT scan of the cervicothoracic junction and/or the thoracic spine should be performed, despite an increased X-ray load.

Since the occurrence of this unique case, clinical examinations are performed with higher caution and in cases of doubt, posttraumatic CT examinations of the spine with multi-plane reconstructions are routinely carried out at our Radiology department after accidents that have shown the potential for undetected spinal trauma, even in apparently neurologically intact patients, despite the attendant's expense.

References

1. Apple DF, Anson CA, Hunter JD, Bell RB (1995) Spinal cord injury in youth. *Clin Pediatr* 34:90–95
2. Avellino AM, Mann FA, Grady MS, Chapman JR, Ellenbogen RG, Alden TD, Mirza SK (2005) The misdiagnosis of acute cervical spine injuries and fractures in infants and children: the 12-year experience of a level I pediatric and adult trauma center. *Childs Nerv Syst* 21:122–127
3. Banit DM, Grau G, Fisher JR (2000) Evaluation of the acute cervical spine: a management algorithm. *J Trauma* 49:450–456
4. Blackmore CC, Ramsey SD, Mann FA, Deyo RA (1999) Cervical spine screening with CT in trauma patients: a cost-effectiveness analysis. *Radiology* 212:117–125
5. Bracken MB, Holford TR (2002) Neurological and functional status 1 year after acute spinal cord injury: estimates of functional recovery in National Acute Spinal Cord Injury Study II from results modelled in National Acute Spinal Cord Injury Study III. *J Neurosurg Spine* 96:259–266
6. Brown RL, Brunn MA, Garcia VF (2001) Cervical spine injuries in children: a review of 103 patients treated consecutively at a level I pediatric trauma center. *J Pediatr Surg* 36:1107–1114
7. Davis JW, Phreaner DL, Hoyt DB, Mackersie RC (1993) The etiology of missed cervical spine injuries. *J Trauma* 34:342–346
8. Henry P, Lyne ED, Lifton C, Saliccioli G (1977) Clinical review of cervical spine injuries in children. *Clin Orthop Relat Res* 129:172–176
9. Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker MI, for the National Emergency X-Radiography Utilization Study Group (2000) Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. *N Engl J Med* 343:94–99
10. Magerl F, Aebi M, Gertzbein SD, Harms J, Nazarian S (1994) A comprehensive classification of thoracic and lumbar injuries. *Eur Spine J* 3:184–201
11. McGrory BJ, Klassen RA, Chao EYS, Staeheli JW, Waever AL (1993) Acute fractures and dislocations of the cervical spine in children and adolescents. *J Bone Joint Surg Am* 75:988–995
12. Rieger M, Mallouhi A, El Attal R, Kathrein A, Knop C, Blauth M, Jaschke W (2006) Acute diagnosis of spinal trauma. *Radio-loge* 46:527–544
13. Scapinelli R, Balsano M (2002) Traumatic enucleation of the body of the sixth cervical vertebra without neurologic sequelae: a case report. *Spine* 27:321–324
14. Viccellio P, Simon H, Pressman BD, Shah MN, Mover WR, Hoffman JR; NEXUS Group (2001) A prospective multicenter study of cervical spine injury in children. *Pediatrics* 108:E20