

Terry L. Levin
Walter E. Berdon
Ian Cassell
Netta M. Blitman

Thoracolumbar fracture with listhesis— an uncommon manifestation of child abuse

Received: 30 June 2002
Accepted: 31 October 2002
Published online: 6 March 2003
© Springer-Verlag 2003

T.L. Levin (✉) · N.M. Blitman
Department of Radiology, Montefiore
Medical Center, 111 E. 210th Street, Bronx,
New York, NY 10467-2490, USA
E-mail: jeb1@aol.com
Tel.: +1-718-9204865

W.E. Berdon
Department of Radiology, Babies Hospital,
New York Presbyterian Hospital,
New York, USA

I. Cassell
Department of Radiology, Phoenix
Children's Hospital, Phoenix, Arizona,
USA

Abstract *Background:* Thoracolumbar fracture with listhesis (FL) is an uncommon manifestation of child abuse (increasingly known as non-accidental trauma), with only six prior reports in the literature.

Objective: This article seeks to call attention to FL of the thoracolumbar spine in abused children and infants. *Materials and methods:* We reviewed plain films, CT and MR images in seven new cases of FL of the thoracolumbar spine in abused children ages 6 months to 7 years, two of whom became paraplegic from their injuries. *Results:* Findings varied from subtle listhesis of one vertebra on another to frank vertebral dislocation, most com-

monly at L1/2. Paravertebral calcification was present in all but one case. In two children, thoracolumbar FL was the only radiographic sign of abuse. *Conclusion:* Radiographic findings of FL of the thoracolumbar spine may be subtle and may be erroneously interpreted as due to a congenital or neoplastic cause. While other signs of child abuse should be sought, spinal injury may be the sole sign of abuse. Recognition of this entity is important to pursue the diagnosis of abuse.

Keywords Abuse · Nonaccidental trauma · Spine · Fracture · Dislocation

Introduction

Spinal trauma in the setting of child abuse (increasingly known as nonaccidental trauma) is unusual, with spine fractures comprising only 3% [1] of abuse-related fractures. Fracture with listhesis (FL) of the thoracolumbar spine, first described by Swischuk in 1969 [2], is a rare occurrence. In the past 33 years since Swischuk's first report, there have been only six additional reports (Table 1), although it is discussed in the second edition of Kleinman's *Diagnostic Imaging of Child Abuse* [3]. The radiographic findings of FL may be seen following acute injury or after fracture healing, and may be misinterpreted as due to congenital, infectious, or even neoplastic causes. We present seven cases of FL of the thoracolumbar spine in abused children and infants.

Materials and methods

Imaging studies from three hospitals (including plain radiographs of seven patients, CT of two patients, and MRI of two patients) were reviewed in seven children ages 6 months to 7 years with FL of the thoracolumbar spine. Clinical findings were also reviewed.

Results

At presentation, two of the seven children with thoracolumbar FL were paraplegic, while the rest had no neurological signs or symptoms (Table 2). Although five children had additional findings of abuse, in two, the thoracolumbar spine injury was the *only* radiographic sign of abuse. Review of plain films revealed that the injury occurred most commonly at L1/2 and

Table 1 Previously reported cases (*LE* lower extremities, *yr* years, *mo* months, *PV-Ca* paravertebral calcification, *Fx* fracture, *disloc* dislocation)

References	Paraplegia +/-	Age/sex	Imaging	Level of spine injury	Other imaging findings of abuse
Swischuk 1969 [2]	“Weak” LE	2 yr/female	Plain film	L2/3, PV-Ca	Fx/disloc cervical spine with spontaneous reduction, Fx clavicle, proximal femurs
Cullen et al. 1975 [6]	–	Case 1, 14 mo/male	Plain film	T3/4	Fx femur, ribs
	–	Case 2, 14 mo/male	Plain film	T12/L1	Fx skull, humerus
	–	Case 3, 16 mo/male	Plain film	T11/12	Fx radius, ulna, femur, humerus
Faure et al. 1978 [4]	–	3 mo/female	Plain film	L3/4	Fx clavicle, rib, pubis
Renard et al. 1978 [7]	+	13 mo/male	Plain film	T12/L1	None
Diamond et al. 1994 [8]	+	12 mo/female	Plain film, MRI, CT	T12/L1	None
Carrion et al. 1996 [1]	“Weak” LE	Case 1, 12 mo/female	Plain film, MRI	T12/L1	None
	+	Case 2, 9 mo/male	Plain, CT	T12/L1	None
Gabos et al. 1997 [9]	+	15 mo/female	Plain, CT, MRI	L1/2	None

Table 2 Current series (*yr* years, *mo* months, *PV-Ca* paravertebral calcification, *Fx* fracture)

Case	Paraplegia +/-	Age/sex	Imaging	Level of spine injury	Other imaging findings of abuse
1	+	4 yr/female	IVP	L1/2 PV-Ca	None
2	+	15 mo/male	MRI, plain film	L1/2	Avascular left kidney
3	–	2 yr/female	Plain film	L1/2 PV-Ca	Metatarsal Fx
4	–	6 mo/female	Plain film, MRI, CT	L1/2 PV-Ca	Femur/humerus Fx
5	–	10 mo/male	Plain film	T11/12, L2/3 PV-Ca	Tibia/clavicle Fx
6	–	7 yr/male	Plain film	L1/2 PV-Ca	Distal humerus Fx
7	–	2 1/2 yr/female	Plain film, CT	L1/2 PV-Ca	Proximal humerus Fx

varied from subtle listhesis of one vertebra on another with compression deformity of the affected vertebra (Fig. 1), to frank vertebral dislocation (“vagabond vertebra” [4]) of one vertebra on another. Unilateral or bilateral paravertebral calcification was present in all but one case (Fig. 2), indicating a chronic injury. In one patient, the listhesis was seen to advantage on oblique films (Fig. 3). CT demonstrated a fracture through the posterior elements in one case (Fig. 4) and paravertebral calcific debris in the second case (Fig. 5), which was initially misinterpreted at an outside institution as neuroblastoma. MRI findings in two patients confirmed FL of the spine as well as new and old blood in the prevertebral soft tissues (Fig. 6), and cord displacement.

Discussion

Although vertebral fracture in child abuse was reported in 1962 by McHenry [5], it was not until 1969 that attention was drawn to a combination of fracture with listhesis of the thoracolumbar spine by Swischuk [2] in his article on spine trauma and abuse. Included in Swischuk’s series of seven cases of child abuse and spine injury was a 2-year-old child with FL of the lumbar spine, characterized by disc space narrowing, malalignment of the affected vertebrae, and paravertebral calcification. More recently, additional cases of acute FL of the thoracolumbar spine have been reported [1, 4, 6, 7, 8, 9]. In one report, the displaced vertebra was referred to



Fig. 1 Lateral view of the lumbar spine in patient 5. Mild compression deformity of the superior endplate of the L3 vertebra (*arrow*) is seen with a subtle forward listhesis of the L3 vertebra relative to the L2 vertebra. Also note fracture deformity of T11



Fig. 3 Oblique film from an IVP in patient 1. Compression of the superior endplate of the L2 vertebra is evident. The forward listhesis of the L2 vertebra is seen to advantage on the oblique view

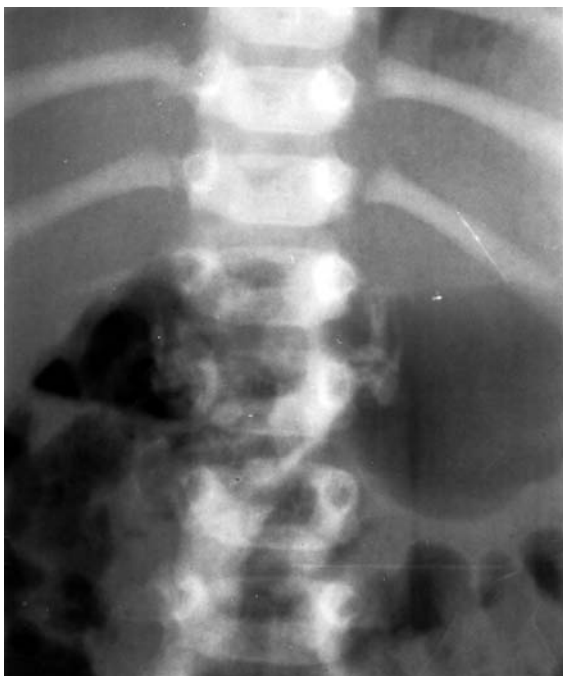


Fig. 2 Frontal view of the lumbar spine in patient 3. There is disc space narrowing at L1/2 with bilateral paravertebral calcification

as the “wandering” or “vagabond” vertebra [4]. These children all presented with neurological symptoms ranging from weakness to lower extremity stiffness to paralysis, prompting evaluation of the thoracolumbar spine. In at least three cases, the clinical and radiographic findings were initially misinterpreted as secondary to an infectious process [1, 6] or congenital [8] in nature, and in one, antibiotic therapy was continued for several months before the correct diagnosis was made [6]. Additional skeletal findings of abuse, while present in some cases, were not universal.

A possible mechanism of injury in FL of the thoracolumbar spine is best described by Carrion et al. [1] and is well discussed in the second edition of Kleinman’s *Diagnostic Imaging of Child Abuse* [3]. The injury is not produced by flexion alone. Rather, it is due to a combination of an axial load, flexion, and rotation (Fig. 7).



Fig. 4 CT scan of the abdomen in patient 7. Fractures through the posterior elements of the L2 vertebra, as well as paravertebral calcification (*arrow*) are present

A fracture through the neurocentral synchondrosis which joins the neural arches to the vertebral centrum occurs, thus separating the neural arches from the vertebral centrum. In addition, there is a Salter-type fracture through the endplate physes. The endplate physes remain adherent to the intervertebral disc. These fractures result in a freely mobile centrum which may displace, and with rotational force, rotate into the neural canal, producing neurological injury.

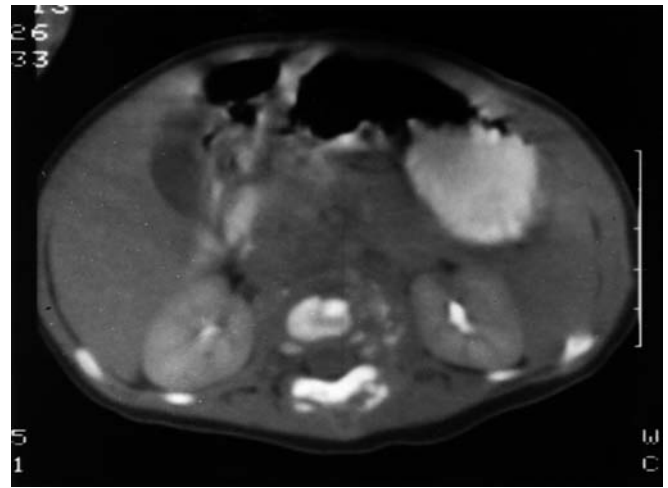


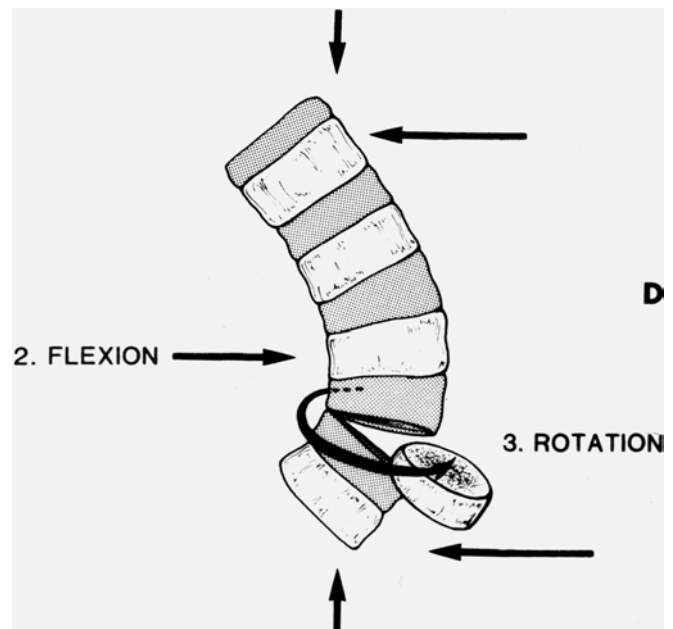
Fig. 5 CT scan of the abdomen in patient 4. Prominent prevertebral soft tissue with paravertebral calcific debris is present

FL of the thoracolumbar spine is an unusual injury and there are few reports in the radiographic literature. The findings may be quite obvious or, as in several of our cases, may be subtle and appear as a mild spondylolisthesis. Additionally, they may be the *sole* injury in cases of child abuse. Injuries with delayed presentations may demonstrate paravertebral calcification which may erroneously suggest the diagnosis of neuroblastoma. Delayed presentation may also include asymptomatic kyphotic deformity which may be interpreted as congenital. Whether acute or chronic, the injury is significant, indicates severe trauma, and should be interpreted as such. Skeletal survey and bone scan are indicated, as well as head CT and/or MRI.

Fig. 6 **a** Frontal view of the lumbar spine in patient 4. There is a compression deformity of the L2 vertebra with sclerosis. There is lateral displacement of the L2 vertebra relative to the L1 vertebra with narrowing of the L1/2 disc space. **b** Coronal T1-weighted image of the abdomen in the same patient. Compression fracture of the L2 vertebra is present, with lateral displacement of the L2—L5 vertebrae. **c** Axial T2-weighted image in the same patient at the level of the L2 vertebra. Note the low signal prevertebral soft tissue displacing the IVC and aorta anteriorly, consistent with old hemorrhage



Fig. 7 Mechanism of fracture with listhesis of the spine proposed by Carrion et al. [1]. A combination of axial load, flexion, and rotatory forces result in a fracture through the neurocentral synchondroses as well as the superior and inferior vertebral apophyses. The freely mobile vertebral centrum is able to migrate and rotate into the spinal canal (from [1], courtesy of the author)



References

1. Carrion WV, Dormans JP, Drummond DS, et al (1996) Circumferential growth plate fracture of the thoracolumbar spine from child abuse. *J Pediatr Orthop* 16:210–214
2. Swischuk LE (1969) Spine and spinal cord trauma in the battered child syndrome. *Radiology* 92:733–738
3. Kleinman PK (1998) Spinal trauma. In: Kleinman PK (ed) *Diagnostic imaging of child abuse*, 2nd edn. Mosby, St. Louis, pp 149–167
4. Faure C, Steadman CI, Lalande G, et al (1979) La vertèbre vagabonde (The wandering vertebral body). *Ann Radiol* 22:96–99
5. McHenry T, Girdany BR, Elmer E (1963) Unsuspected trauma with multiple skeletal injuries during infancy and childhood. *Pediatrics* 31:903–908
6. Cullen JC (1975) Spinal lesions in battered babies. *J Bone Joint Surg Br* 57:364–366
7. Renard M, Tridon P, Kuhnast M, et al (1978) Three unusual cases of spinal cord injury in childhood. *Paraplegia* 16:130–134
8. Diamond P, Hansen CM, Christofersen MR (1994) Child abuse presenting as a thoracolumbar spinal fracture dislocation: a case report. *Pediatr Emerg Care* 10:83–86
9. Gabos PG, Tuten HR, Leet A, et al (1998) Fracture-dislocation of the lumbar spine in an abused child. *Pediatrics* 101:473–477