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Spinal cord injury without radiographic abnormality in adults

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Spinal cord injury without fractures or bony malalignment on either plain radiographs or computed tomography (SCIWORA) is most commonly found in the paediatric age group. In recent years, magnetic resonance imaging (MRI) has been used to evaluate these patients. The present communication describes SCIWORA in 15 adult patients investigated by MRI. Of the 151 patients with spinal cord injury in 1 year, 15 adult patients had cervical SCIWORA. All patients were evaluated by MRI. The age ranged from 20–60 years. Eleven patients had partial cord injury, two had a complete cord syndrome while two had a central cord syndrome. MRI demonstrated an intervertebral disc prolapse in six patients, intramedullary haematoma/contusion in four and cord oedema in four patients. One patient had multiple disc prolapses and associated intramedullary haematoma. Patients with disc prolapse were operated upon and all showed neurological improvement. The rest of the patients were managed conservatively. There was mild improvement in patients with intramedullary haematomas while those with cord oedema alone showed moderate recovery. The pathogenesis of adult SCIWORA is possibly different from that in paediatric age group. Most of the patients with SCIWORA show some abnormality on MR imaging. MRI should therefore be done in all patients with spinal cord injury for diagnostic and prognostic purposes.

Keywords: trauma; spine; cord; radiology; SCIWORA

Introduction

The syndrome of spinal cord injury without evidence of vertebral fractures or bony malalignment on either plain radiographs or on computed tomography is termed spinal cord injury without radiographic abnormality (SCIWORA).[1] In recent years magnetic resonance imaging (MRI) has been used for evaluating patients with SCIWORA and has been found to be superior to CT for detection of ligamentous injuries, traumatic disc prolapse, intramedullary lesions and extradural haematomas.[2–4] SCIWORA is seen in 4%–66.7% of all paediatric spinal injuries[5–8] and most of the reports on SCIWORA deal with the paediatric age group.[3,7,9] The present study documents SCIWORA in 15 adult patients and describes their MRI findings. The mechanism of spinal cord injury in the paediatric age group has been postulated to be different from that in adults because of anatomical and biomechanical differences in the spine at various ages.[7] Cord injury possibly occurs when the highly elastic ligaments in the juvenile spine allow transient intervertebral displacements that result in cord injury.[9] The demonstration of SCIWORA in adult patients in the present communication could point to the possibility of a different pathogenic mechanisms involved in production of neural damage.

Patients and methods

In the last year, 151 adult patients with spinal cord injury were admitted to the Department of Neurosurgery at the Postgraduate Institute of Medical Education and Research, Chandigarh, India. Fifteen adult patients among these had cervical SCIWORA and form the present study group. During this period we did not admit any paediatric patient with spinal cord injury. All these patients were investigated by plain X-ray of the cervical spine, including dynamic flexion-extension films. Failure to detect any bony abnormality, despite persistent significant neurological deficits, called for MRI examination of these patients. Their clinical profile is given in Table 1. The neurological syndromes at presentation were classified according to the level and severity (Table 1). The functional status at presentation and discharge was judged as per Frankel's Grade.[10]

The age range was between 20 and 60 years. Twelve of the 15 patients were male. Two patients had complete cord syndrome (Frankel grade A), eleven had partial cord injury while

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two patients had a central cord syndrome. The level of injury was in the cervical region in all patients (Table 1).

Results

The MRI findings were divided into three groups: (A) Prolapsed intervertebral disc (PIVD): six patients; (B) Intramedullary haematomas/cord contusion; four patients; and (C) Cord oedema: four patients.

One patient had evidence of both intramedullary haematoma and multiple and disc prolapses.

Group A

Of the six patients in this group, four had a single level cervical disc while two patients had two level cervical discs. The plain X-ray of the spine were normal in all of them and the disc prolapse was diagnosed only on MRI examination (Figure 1). All these patients were treated by anterior cervical discectomy and all of them demonstrated clinical improvement at the time of discharge. At 6 months follow-up, all of them were either back to normal work or with minor alterations in their occupation.

Group B

Patients in this group had evidence of cervical intramedullary haemorrhage (Figure 2). One of these had a complete cord syndrome (Frankel Grade A) and three had partial cord syndrome (Frankel Grade C). Three patients were in the age group 50–60 and plain X-rays of the cervical region did not reveal any bony injury. All four patients were managed conservatively and did not show any significant neurological improvement at discharge. Neurological examination at 6 months showed that these patients were in the same Frankel grade as at the time of discharge although all of them demonstrated some degree of motor improvement.

Table 1 Clinical summary of patients with SCIWORA

Case no.	*Age*	*Sex*	*Mode of injury*	*Level of injury (clinical)*	*Neurological syndrome*
1.	40	F	fall from roof	C_5	complete
2.	20	M	RTA	C_6	complete
3.	52	M	RTA	C_4	partial
4.	50	M	RTA	C_4	central
5.	40	M	fall of load onto head	C_6	partial
6.	28	M	RTA	C_5	partial
7.	60	M	fall from height	C_4	severe partial
8.	52	F	RTA	C_5	central
9.	30	M	fall from height	C_5	partial
10.	25	M	RTA	C_5	partial
11.	45	M	RTA	C_4	partial
12.	35	M	RTA	C_4	partial
13.	38	F	RTA	C_4	partial
14.	22	M	RTA	C_5	partial
15.	45	M	fall from height	C_6	severe partial

Case no.	*Frankel grade at admission*	*MRI findings*	*Management*	*Frankel grade at discharge*
1.	A	intramedullary haemorrhage at C_5-C_6 level	conservative	B
2.	A	cord oedema C_{6-7}	conservative	A
3.	C	PIVD C_{3-4} and C_{4-5}	anterior cervical discectomy	D
4.	C	intramedullary haemorrhage at C_{3-4}	conservative	C
5.	C	PIVD C_{5-6}	anterior cervical discectomy	D
6.	C	PIVD C_{5-6} and C_{6-7}	anterior discectomy	D
7.	C	cord contusion at C_3, C_4 and C_5	conservative	C
8.	C	cord contusion with mild PIVD at C_{3-4} and C_{5-6}	conservative	D
9.	C	PIVD C_{4-5}	anterior cervical discectomy	E
10.	D	PIVD C_{5-6}	anterior discectomy	E
11.	C	cord oedema C_4-C_5	conservative	D
12.	C	cord oedema C_4-C_6	conservative	D
13.	C	cord oedema C_{4-5}	conservative	D
14.	D	cord oedema C_{5-7}	conservative	D
15.	C	PIVD C_{6-7}	anterior discectomy	D

Figure 1 MRI demonstrating a traumatic disc herniation at C_{5-6} level. The bony architecture is intact

Figure 2 T_2 weighted sagittal MRI showing a small intramedullary contusion at C_3-C_4 level with surrounding cord oedema extending from C_2 to C_4

Group C

There were four patients in this group. Plain X-rays of the spine were normal and MRI demonstrated a hypointense signal within the cord in T_1 weighted images and a hyperintense signal on T_2 weighted images consistent with cord oedema (Figure 3). All were managed conservatively. Three patients showed improvement by one Frankel grade at the time of discharge while one remained the same. At 6 months follow-up, the fourth patient also had improvement from Frankel grade A to B.

One patient with three level discs and cord contusion had an anterior discectomy. He showed neurological improvement from Frankel grade B to C.

Discussion

SCIWORA is a diagnosis generally found in children because of the unique biomechanics of the immature spine, ligaments and soft tissue.[1] Melzak[11] reported 16 cases of SCIWORA among 29 children with spinal injury. Burke[12] reported 12 children with spinal cord injury with no evidence of bony injury on X-ray. Pang and Wilberger[7] documented 24 cases among 36 children and concluded that this is a common entity in paediatric spinal trauma. More recently, Grabb and Pang[9] reported 18 children with SCIWORA. The features of the paediatric spine which make it more susceptible to SCIWORA in contrast to the adult spine are: (a) more horizontal orientation of the facet joints (b) anterior wedging of the superior aspects of the vertebral bodies and (c) more 'elastic' ligaments and joint capsules. These allow for excessive intersegment motion in flexion, extension or distraction, resulting in neural injury without bony or overt ligamentous breaks.

In patients of late middle age and old age, a syndrome of spinal cord injury without demonstrable skeletal injury was documented by Crooks and Birkett.[13] Many of these patients have pre-existing cervical spondylitic changes resulting in narrowing of the sagittal diameter of the cervical canal. Hyperextension injuries in these patients cause the cord to be pinched between the osteophytes and the inward bulging of the interlaminar ligaments producing an acute central cord syndrome. In the present communication, four of the 15 patients were in the age range 50–60 years. Clinically, they presented as either central cord or partial cord syndrome and MRI demonstrated intramedullary cord haemorrhage/contusion in all three.

Figure 3 MR scan demonstrating diffuse cord oedema at C_5-C_6 level. There is associated inbuckling of posterior longitudinal ligament and cord indentation at C_5 level

Eleven patients in the present series were in the age range 20–40. It is exceedingly rare to find SCIWORA in this age range.[14] The mechanical properties of the spines of patients of this age group are such that fractures of the body or neural arch or locking of facets occurs before the neural structures are injured.[7] Six patients had a traumatic disc prolapse in the cervical region which was responsible for the neurological deficit. Traumatic disc extrusion with rupture of the annulus does occur rarely in adults but is usually associated with fracture of the adjacent vertebral bodies. MRI evidence of anterior and posterior longitudinal ligamentous injury and disc protrusion were provided in a recent study.[9]

A direct blow to the spine insufficient to cause skeletal damage could set up shock-wave oscillations in the cord causing 'slapping damage' to the cord against the bony spinal canal.[15] Some patients in the present study could have had neurological damage due to this mechanism.

In children, the MRI findings have been divided into two groups; extraneural and neural. Extraneural lesions include ligamentous injury and disc herniations while neural findings include intramedullary haemorrhages and cord oedema.[9] A similar spectrum was seen in the patients with adult SCIWORA in the present series.

The best neurological recovery occurred in patients with prolapsed intervertebral discs. This is not surprising because these patients had only extraneural disease or ligamentous injury with no evidence of cord damage and surgical removal of the compressing element led to neurological recovery. Patients with evidence of neural damage or oedema recovered only partially or not at all. MRI therefore has a definite prognostic role in patients with SCIWORA.

Conclusion

In recent years, MRI has been increasingly used for management of patients with spinal cord injury. In patients with SCIWORA, MRI is able to pick up lesions such as ligamentous injury, disc herniations, cord haematomas and oedema. Most of the cases of SCIWORA have shown definite abnormalities on MRI studies which correlate well with the clinical picture and in addition are of prognostic significance. The term SCIWORA is likely to become redundant and may only be useful in very special instances as few patients with spinal cord injury have no imaging abnormalities.

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