Spinal Cord (2003) 41, 521–526

www.nature.com/sc

Case Report

Traumatic cervical instability associated with cord oedema and temporary quadriparesis

M Wenger*[,1], PJ Adam[2], F Alarcón[3] and T-M Markwalder[4]

[1]*Neurosurgery, The Hirslanden Group, Klinik Beau-Site Bern, Switzerland;* [2]*Gynaecological Department, Bezirksspital Belp, Belp, Switzerland;* [3]*Neurological Department, Clinica Pasteur, Hospital Eugenio Espejo, Quito, Ecuador;* [4]*Attending Neurosurgeon FMH, Bern-Muri, Switzerland*

Study design: A case report of blunt cervical spine trauma associated with cord oedema at the C3/C4 level with temporary Frankel/American Spinal Injury Association Grade A quadriparesis and motion segment instability without evidence of associated bony lesions (spinal cord injury without radiological abnormality, SCIWORA lesion).
Objectives: By means of a rare and illustrative case, the reader's attention is focused on eventual marked cervical motion segment instability in SCIWORA patients.
Setting: A department of Neurology in Quito, Ecuador and a department of Neurosurgery in Bern, Switzerland.
Method: A 73-year-old man sustained blunt cervical spine trauma. After resolution of paraparesis, dynamic studies of the cervical spine revealed translational instability of C3 over C4. The patient underwent segment fusion by intervertebral cage insertion and plate fixation.
Results: The patient had recovered almost completely from tetraparesis under conservative treatment. The postoperative course was uneventful. Solid bony fusion of the C3/C4 motion segment was obtained.
Conclusion: Despite normal cervical alignment, the lack of bony lesions and neurological recovery, magnetic resonance imaging and dynamic studies may reveal marked translational cervical motion segment instability requiring segment fusion in order to prevent ongoing damage of the spinal cord.
Spinal Cord (2003) **41,** 521–526. doi:10.1038/sj.sc.3101485

Keywords: cervical spine; trauma; cord oedema; quadriparesis; spine surgery; instrumentation

Introduction

Blunt cervical spine trauma usually is assessed by use of the standard trauma series with three-view plain radiographs between the occiput and the cervicothoracic junction (anteroposterior and lateral views, open-mouth odontoid view; oblique views for five-view exam[1]) and computed tomography (CT) in the area of the assumed injury.[1–3] However, in recent years this evaluation protocol was challenged by the introduction of magnetic resonance imaging (MRI) and helical CT of the complete cervical spine.[4] The latter diagnostic methods are increasingly used in the acute stage and especially in case of neurological dysfunction at first presentation or in case of negative results of initial plain films and conventional CT.[5–7] Moreover, plain films and CT, on which spinal cord injury without radiological abnormality (SCIWORA) diagnosis usually is based, may be insufficient and additionally miss soft-tissue lesions.[3,8,9] MRI depicts several types of intrinsic cord lesions as well as neurocompressive and discoligamentous injuries.[4,10,11] The latter may be indicative of an unstable cervical spine with the danger of ongoing cord damage.[12] Such conditions can be validated in the reliable patient by means of dynamic flexion and extension lateral radiographs.[2] Unstable cervical motion segments require a fusion procedure to avoid ongoing damage.[12]

SCIWORA-type injuries are very unlikely to occur in elderly people. In this age group such injuries are usually associated with radiological evidence of major spondylotic changes allowing for significant traction or compression of the cord during the accident and/or bony lesions and malalignment. Such cord damage rarely fully resolves in old persons even though different types of cord lesions behave differently. With increasing resolution, MRI is a very useful tool in evaluating prognosis of several of these lesions.[4,5,7–9,11,13–15]

*Correspondence: M Wenger, Neurosurgery, The Hirslanden Group, Klinik Beau-Site, Schänzlihalde 11-13, CH-3000 Bern 25, Switzerland

It is the aim of this report to present the assessment and the surgical treatment of a 73-year-old man who presented initially with a complete cord syndrome after blunt cervical spine trauma and to focus the attention on MRI appearance of cord oedema as well as discoligamentous lesions with subsequent spinal instability.

Case report

History and initial clinical presentation

While sleeping in a motor yacht that was lying in a small island harbour overseas, this healthy 73-year-old man sustained a head-first fall out of his narrow upper cabin berth. During the fall, he awakened. However, he could not avoid hitting the edge of the lower berth with his forehead. He was not able to recall the mechanism of trauma in greater detail but a hyperextension-compression type of injury was most likely. The patient did not lose consciousness, he was able to breathe and speak normally, but could not move his extremities at all and he lost sensibility of the whole body beyond the jugulum (sensory level at C4). For 1 h the patient was completely tetraparetic (Frankel[16]/American Spinal Injury Association (ASIA)[17] Grade A). Thereafter, he first could move his left foot, then his left leg. Sensibility in the left leg resolved. After 1 h, his right leg recovered in the same distal to proximal manner. However, some weakness of the thighs persisted. About 1 h after the accident he was able to urinate. Several medical doctors who were aboard this ship as part of the tourist party confirmed these findings (PJA). They put the patient into an improvised cervical collar, fixed him on an unhinged cabin door and supervised the patient during an adventurous journey of several hours to the capital Quito. During this journey first the right arm and later the left arm partially recovered from distal to cranial.

At admission in the local hospital on the same day, the neurologist (FA) found 4/5 hemiparesis and hemihypalgesia on the left side, clumsiness of the right hand for fine movements and nuchal pain as well as pain on the left side of the body. Apart from a small superficial cutaneous lesion at the forehead there were no other injuries. The brain MRI showed normal findings, however, in the cervical MRI examination (Signa, 1.0 T; GE Medical Systems, Milwaukee, WI, USA), performed 16 h after the accident, there was marked oedematous change of the cord of about 1.2 cm rostrocaudal length at the C3/C4 level without evidence of intra-axial haematoma or other lesions (iso- to slightly hypointense and marked hyperintense signals of the whole cord cross-section in the T1- and the T2-weighted images, respectively (Figure 1a and b)). The patient was given methylprednisolone (125 mg every 6 h for 3 days, 125 mg every 8 h for 1 day and 125 mg on the 5th day), meloxicam (15 mg every day) and ranitidine. He was immobilized in a Philadelphia collar and had careful physical therapy of the extremities (FA).

At 2 days after the accident, he was able to ambulate independently and after 5 days his condition was considered to be stable enough for the intercontinental flight back home. There was no sphincteric dysfunction. However, at that time he still complained of some clumsiness of the right hand and there was minimal weakness of both the arms.

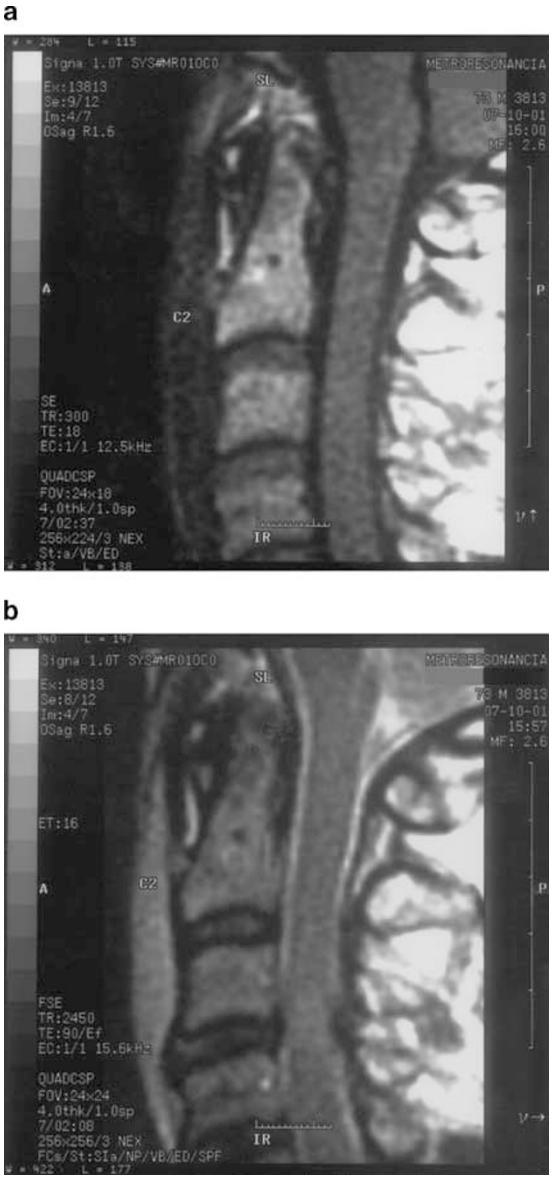

Figure 1 Sagittal mid-line MRI 16 h after the accident. (**a**) is T1-weighted. The oedema is scarcely visible because it appears as an iso- to hypointense signal change. The image 1(**b**) is T2-weighted. There is a high intense signal change of the cord of about 1.2 cm rostrocaudal length, representing cord oedema. Both, the C3/C4 disc and the posterior longitudinal ligament are disrupted. The C3/C4 disc slightly protrudes posteriorly

Preoperative assessment and preoperative clinical presentation

At 9 days after the accident, the patient mainly complained of severe nuchal pain. Neurologically there

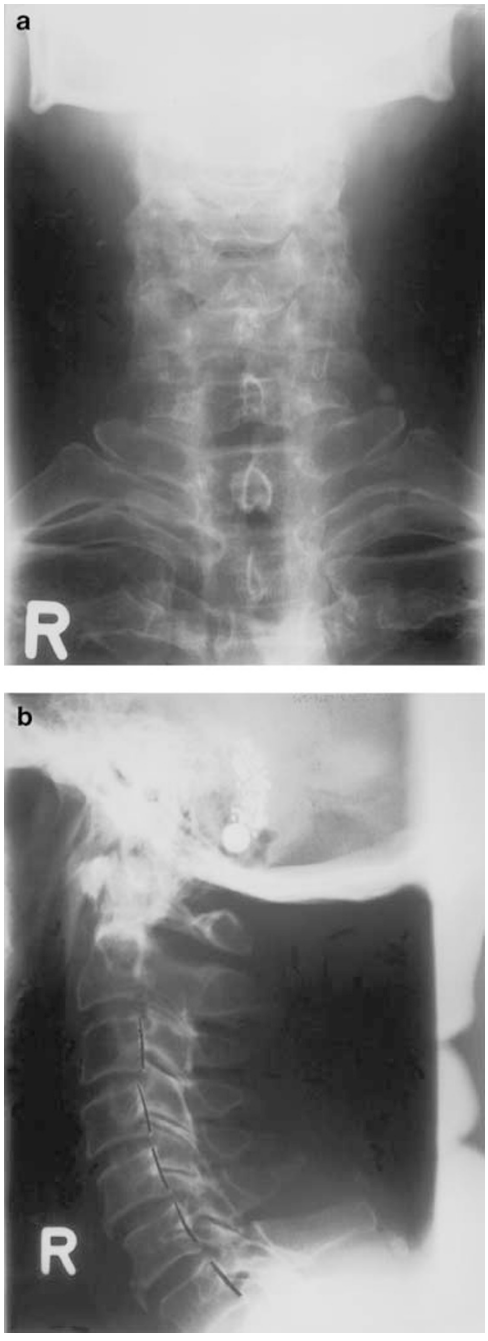

Figure 2 Anteroposterior (**a**) and lateral (**b**) plain X-ray of the cervical spine. There is no osseous lesion; however, there is slight posterior translation of C3 over C4 in the lateral view

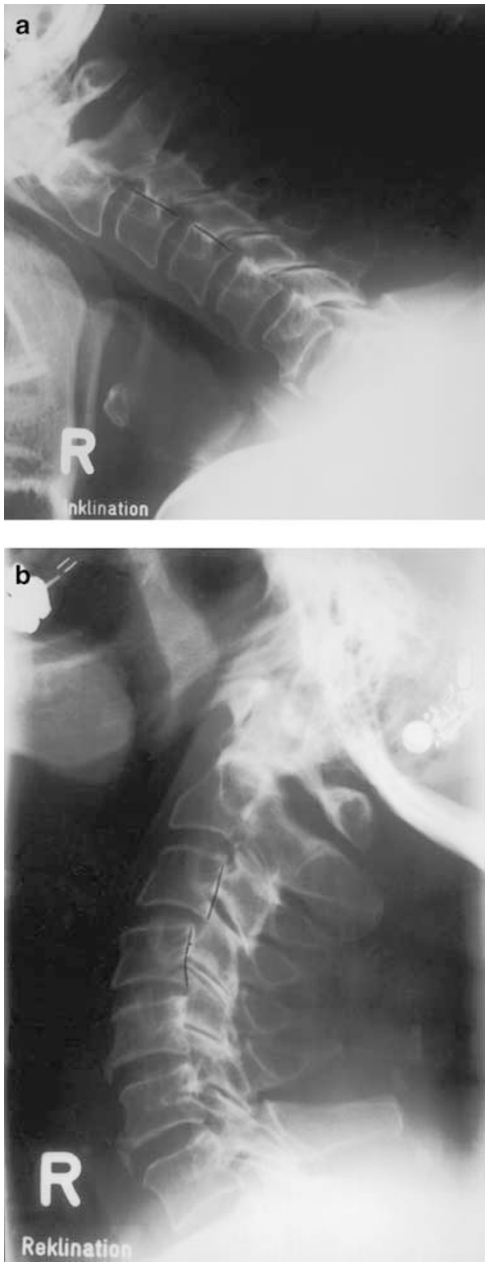

Figure 3 Active dynamic study of the cervical spine in this reliable patient. Lateral plain X-ray in maximal flexion (**a**) and extension (**b**) There is marked instability of the C3/C4 motion segment with posterior translation of C3 over C4 in extension

remained a 4/5 weakness only of the left M. biceps brachii, increased reflexes in the left arm and a slight clumsiness of the right arm. The Oppenheim sign was positive on the right side.

In the MRI performed on the day of the accident (Figure 1a and b) as well as in the conventional radiographs there was no bony lesion (Figure 2a and b). Dynamic conventional radiological studies[2] that were performed after having returned home, showed marked instability of the C3/C4 motion segment and reposition of C3 on C4 in extension (Figure 3a and b).

Surgical management

The surgical intervention was performed by the senior author (TMM). After fiberoptic intubation total intravenous anaesthesia was maintained. A Gardner–Wells skull tong was applied for continuous intraoperative axial traction. Through a right mediolateral collar incision along the sternocleidomastoid muscle the

neurovascular bundle was displaced laterally and the oesophagus and the trachea medially. The vertebral bodies of C3 and C4 were identified using C-arm fluoroscopy (Siremobil 2000, Siemens, Germany). Intraoperatively marked instability of this motion segment was present, confirming the preoperative radiological assessment. By use of microtechniques (Wild-Leica M 655 microscope, Switzerland) the C3/C4 intervertebral disc, which was ruptured and slightly bulging posteriorly, was completely removed down to the ruptured posterior longitudinal ligament. After freshening of both endplates, a cervical cage (Osta-Pek, Co-Ligne, Zürich, Switzerland; 12-6-6 mm carbon cage) filled with cancellous bone taken from the right iliac crest was introduced into the C3/C4 intervertebral space, resulting in subtotal reposition of the C3 over the C4 vertebra. A trapezoidal plate (Caspar, Aesculap, Tuttlingen, Germany; 28 mm) was bent somewhat less than post-traumatic regional hyperlordosis at the C3/C4 level. Under fluoroscopic control first two bicortical screws were introduced through the plate into the vertebral body of C4. Thereafter, traction was applied on this motion segment by inserting the two C3 screws and thus correcting the alignment of these two vertebral bodies to the curve of the prebent plate, representing correct anatomic lordosis.

The patient was given perioperative antibiotic prophylaxis and ultracortene.

Figure 4 Lateral plain X-ray of the cervical spine 6 weeks postoperatively. There is correct alignment of the cervical spine and increasing bony fusion of the C3/C4 motion segment

Postoperative course

The postoperative course was uneventful. The neurological findings immediately after the operation were the same as before the intervention. At 1 week after the operation there was minimal clumsiness of the right hand while writing (without change of writing face) and minimal paresthesia of both thumbs (Frankel/ASIA Grade E). The patient was asked to wear a Philadelphia collar for 12 weeks. The first radiological control after 6 weeks showed increasing bony fusion of the C3/C4 motion segment and correct cervical alignment (Figure 4).

Discussion

The acronym SCIWORA syndrome[18] refers to spinal cord injury without radiological abnormality. SCIWORA is most likely to occur in blunt cervical trauma of children beyond the age of 8 years because of the high elasticity of the paediatric spine, resulting from unique anatomic and biomechanical properties.[6,12,13,18,19] In adults, cervical spinal cord injury usually is associated with bony malalignment, locking of facets, disruption of the vertebral body or fracture of elements of the neural arch. Since the introduction of MRI, a post-traumatic abnormality can frequently be depicted in the spine of SCIWORA patients.[13]

Spinal cord injury without radiographic evidence of trauma, the so-called SCIWORET syndrome,[20] is associated with the radiological delineation of spondylotic changes such as bony spurs, cervical canal stenosis, protruded discs and ossification of posterior longitudinal ligament (OPLL).[6,19] These degenerative changes could allow for damage to the neural structures by excessive traction or pinching during the accident.[6,13,19,21,22] SCIWORET patients frequently present with central cord syndrome.[13,19,23] Therefore, an eventual neurological dysfunction is most likely to affect the upper extremities and especially the hands.[19] In the adult, SCIWORET is encountered more frequently than SCIWORA syndrome, even though both conditions are rare.[9,10,12,19]

In recent years, the radiological assessment protocol for acute cervical spine trauma was challenged: increasingly the three standard radiological views are combined with MRI or helical CT of the complete cervical spine instead of conventional CT.[5–7] Especially in patients with neurological dysfunction, MRI probably is the first radiological modality to be applied.[4,5] Multiplane MRI not only depicts eventual neurocompression and discoligamentous injury, it may also show haematomyelia, cord transection and cord oedema.[4,10] Cord lesions with T1-weighted iso- to hypointense and T2-weighted hyperintense MRI images are suggestive of cord contusion and oedema.[5,7,10,13,14] At the present time, MRI resolution for differentiation of oedema with or without petechial haemorrhage is probably not yet reliable enough. Our patient most likely had no

haematomyelia, favouring his almost complete recovery within a short period of time (Frankel/ASIA Grade E).

Discoligamentous injury may be the only evidence that subluxation and immediate spontaneous reduction had occurred during the accident. This may explain the mechanism of trauma to the cord if no other lesion is found. In the absence of other traumatic sequelae and of significant spondylarthrotic changes our patient probably sustained this type of blunt injury to the cervical spine (SCIWORA).

Falls to the ground and falls from height are the most common causes of such accidents.[6,19] If there is a cord lesion without bony disruption, hyperextension is the most probable mechanism of trauma.[6,24,25] In these instances cervical trauma without bony lesion and malalignment typically affects the C3/C4 (70%[15]) and the C4/C5 levels.[6,15] Since discoligamentous disruption may be invisible in the radiological evaluation, the clinical findings and the radiological aspect of the cord nevertheless raise the suspicion of discoligamentous insufficiency that usually can be confirmed in the cooperative patient by active dynamic flexion and extension lateral radiographs.[2,12]

Since MRI reliably depicts the location of the cord lesion, its rostral and caudal ends and the eventual presence of intra-axial haematomas, MRI, together with the clinical presentation, play an important role in the prognosis of the respective cord lesion.[4,5,7–9,11,13–15] Patients with a high intense cord lesion in T2- and a low intense lesion in T1-weighted MRI fare worse than patients with a lesion in T2-weighted images alone.[14,15] For focal cord oedema involving only one spinal segment or less, motor recovery can be expected in 72% of cases, in contrast to 42% in patients with oedema over more than one segment.[7] In patients with intramedullary post-traumatic haematoma, recovery is expected in 9% of cases only.[7] Thus, patients with cord oedema have a better prognosis than patients with intra-axial haematoma and a better prognosis is alloted to cases of small oedema extension and to an involvment of the lower cervical spine.[5,7,9,11,15] Cord injuries in patients with bony disruptions or luxations have a worse prognosis than cord injuries in patients without lesions of structures adjacent to the cord.[10,15] In the latter, probably the traumatic force applied on the spine was smaller.[15] As long as there is neither compression of the cord nor fracture or instability of the spine, application of high-dose methylprednisolone currently is the only treatment option in case of post-traumatic cord oedema, even though the success of steroid therapy for this indication remains moderate.[7,26]

Neurocompression is an indication for operation; however, overt instability of the cervical spine because of discoligamentous injury alone also requires surgery in order to prevent continued damage to the cord.[12] In such conditions, we prefer an anterolateral approach with decompression of the thecal sac by removal of the disrupted disc and the rolled-up parts of the posterior ligament. A tricortical hip graft or a composite carbon cage matching with the shape of the interspace is filled with a cancellous iliac bone graft and inserted. A trapezoidal Caspar plate is prebent to the shape of normal anatomic lordosis and fixed with two bicortical screws in the first vertebral body. Thereafter, traction can be applied on the second vertebral body by insertion of two further screws, thus permanently restoring correct alignment. Patients have to wear a Philadelphia collar for 3 months.

References

1 Davis JW *et al*. The etiology of missed cervical spine injuries. *J Trauma* 1993; **34:** 342–346.
2 Wang JC, Hatch JD, Sandhu HS, Delamarter RB. Cervical flexion and extension radiographs in acutely injured patients. *Clin Orthop* 1999; **364:** 111–116.
3 West OC, Anbari MM, Pilgram Th, Wilson AJ. Acute cervical spine trauma: diagnostic performance of single-view versus three-view radiographic screening. *Radiology* 1997; **204:** 819–823.
4 Selden NR *et al*. Emergency magnetic resonance imaging of cervical spinal cord injuries: clinical correlation and prognosis. *Neurosurgery* 1999; **45:** 956–957.
5 Flanders AE *et al*. Forecasting motor recovery after cervical spinal cord injury: value of MR imaging. *Radiology* 1996; **201:** 649–655.
6 Koyanagi I *et al*. Acute cervical cord injury without fracture or dislocation of the spinal column. *J Neurosurg* 2000; **93** (Spine 1): 15–20.
7 Schaefer DM, Flanders AE, Osterholm JL, Northrup BE. Prognostic significance of magnetic resonance imaging in the acute phase of cervical spine injury. *J Neurosurg* 1992; **76:** 218–223.
8 Benzel EC *et al*. Magnetic resonance imaging for the evaluation of patients with occult cervical spine injury. *J Neurosurg* 1996; **85:** 824–829.
9 Kothari P, Freeman B, Grevitt M, Kerslake R. Injury to the spinal cord without radiological abnormality (SCIWORA) in adults. *J Bone Joint Surg Br* 2000; **82:** 1034–1037.
10 Bhatoe HS. Cervical spinal cord injury without radiological abnormality in adults. *Neurol India* 2000; **48:** 243–248.
11 Flanders AE *et al*. The relationship between the functional abilities of patients with cervical spinal cord injury and the severity of damage revealed by MR imaging. *Am J Neuroradiol* 1999; **20:** 926–934.
12 Pang D, Pollack IF. Spinal cord injury without radiographic abnormality in children – the SCIWORA syndrome. *J Trauma* 1989; **29:** 654–664.
13 Gupta SK *et al*. Spinal cord injury without radiographic abnormality in adults. *Spinal Cord* 1999; **37:** 726–729.
14 Hayashi K *et al*. MRI findings in patients with a cervical spinal cord injury who do not show radiographic evidence of a fracture or dislocation. *Paraplegia* 1995; **33:** 212–215.
15 Shimada K, Tokioka T. Sequential MRI studies in patients with cervical cord injury but without bony injury. *Paraplegia* 1995; **33:** 573–578.
16 Frankel HL *et al*. The value of postural reduction in the initial management of closed injuries of the spine with paraplegia and tetraplegia. I. Comprehensive management and research. *Paraplegia* 1969; **7:** 179–192.
17 Ditunno Jr JF, Young W, Donovan WH, Creasey G. The international standards booklets for neurological and functional classification of spinal cord injury. American Spinal Injury Association. *Paraplegia* 1994; **32:** 70–80.

18 Pang D, Wilberger JE. Spinal cord injury without radiographic abnormalities in children. *J Neurosurg* 1982; **57:** 114–129.
19 Saruhashi Y *et al*. Clinical outcomes of cervical spinal cord injuries without radiographic evidence of trauma. *Spinal Cord* 1998; **36:** 567–573.
20 Tator CH. Clinical manifestations of acute spinal cord injury. In: Benzel EC, Tator CH (eds). *Contemporary Management of Spinal Cord Injury*. American Association of Neurological Surgeons: Park Ridge, IL 1995, pp 15–26.
21 Bhatoe HS. Spinal cord injury [Letter]. *J Neurosurg: Spine* 2001; **94** (Suppl): 339–340.
22 Firooznia H, Ahn JH, Rafii M, Ragnarsson KT. Sudden quadriplegia after a minor trauma. The role of preexisting spinal stenosis. *Surg Neurol* 1985; **23:** 165–168.
23 Taylor AR. The mechanism of injury to the spinal cord in the neck without damage to the vertebral column. *J Bone Joint Surg Br* 1951; **33:** 543–547.
24 Barnes R. Paraplegia in cervical spine injuries. *J Bone Joint Surg Br* 1948; **30:** 234–244.
25 Taylor AR, Blackwood W. Paraplegia in hyperextension cervical injuries with normal radiographic appearances. *J Bone Joint Surg Br* 1948; **30:** 245–248.
26 Bracken MB *et al*. Methylprednisolone or tirilazad mesylate administration after acute spinal cord injury: 1-year follow up. Results of the Third National Acute Spinal Cord Injury randomized controlled trial. *J Neurosurg* 1998; **89:** 699–706.