Paraplegia **30** (1992) 160–164

Hangman's fracture in Singapore (1975–1988)

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A retrospective study of 33 patients with fracture of the ring of the axis (hangman's fracture) admitted to the Spinal Unit of the Department of Rehabilitation Medicine in the Tan Tock Seng Hospital between 1975 and 1988 was carried out. The aims were to establish the causes, mechanism and outcome of injuries that lead to Hangman's fracture in Singapore.

The majority were males (27) and their ages ranged from 16 to 82 with a mean age of 33.7 years. 63.6% (21 cases) were due to road traffic accidents of whom 33% (11 cases) were motorcyclists or pillion riders and 30.3% (10 cases) were drivers or passengers of four wheel vehicles such as cars and vans. Using Effendi *et al's* classification[1], we have 21 type I, 11 type II and one type III fractures. Thirteen type I, 6 type II and one type III cases had no neurological deficit on admission. The rest had deficits ranging from tetraparesis to pure bladder dysfunction. After rehabilitation, 28 (84.8%) of them were able to return to gainful employment within a year of their injuries.

Key words: hangman's fracture; axis fracture-dislocation; aetiology; mechanism; effect.

Introduction

Fracture dislocation of the axis was first studied and described by Haughton in 1866[2] on criminals who had been executed by hanging, a common form of execution in the Roman Empire, and in the British Isles during the early fifth century. In 1913 Wood-Jones[3] noted that a submental knot applied in judicial hanging produced a consistent fatal fracture dislocation of the axis whereby both the axis pedicles were fractured. He postulated that complete disruption of the ligaments and disc between the second and third cervical vetebrae caused cord transection and instant death. The mechanism of injury, according to Wood-Jones[4], was a combination of 2 actions —hyperextension and sudden violent distraction. The term 'hangman's fracture' was first introduced by Schneider *et al* in 1965[5] when they found a similar bony lesion in patients involved in vehicular accidents and other sudden deceleration injuries, and drew attention to the common association of this lesion with injuries to the face or head. The mechanics of the 2 lesions, however, were different in that though hyperextension was common to both lesions, the distraction produced by judical hanging was absent in the other injuries and instead was replaced by axial loading. A more appropriate term used for this type of lesion was 'traumatic spondylolisthesis of the axis'[6] or 'fracture of the ring of the axis'.[1]

Materials

This paper is a retrospective study of 33 patients admitted to the Spinal Unit of the Department of Rehabilitation Medicine, Tan Tock Seng Hospital, between 1975 and 1988. The aims are to determine the causes, mechanism and outcome of injuries leading to hangman's fracture in Singapore.

Results and discussion

Twenty-seven (81.7%) were males and their ages ranged from 16 to 82 years with a mean age of 33.7 years (Table 1).

Table I: Age and sex

Age	Male	Female	Total	%
16–30	15	4	19	57.5
31–45	8	2	10	30.3
46–60	2	—	2	6.1
Above 60	2	—	2	6.1
Total	27	6	33	100

Vehicular accidents accounted for 21 cases of whom 11 were motorcyclists or pillion riders and 10 were passengers of four wheel vehicles such as cars and vans. Industrial accidents were the next commonest cause (7 cases): 5 fell from high rise flats, one was hit by a plank and one fell into a drain (Table II).

Eighteen had associated facial injuries, mainly to the forehead, and this proves that there is an element of hyperextension injury to the neck. Fifteen patients had other associated injuries ranging from fractures of other vertebrae to fractures of long bones (5 had fractures of other vertebrae and 10 sustained fractures of long bones).

On admission 20 patients had no neurological deficits, 7 had incomplete tetraplegia (3 with central cord syndrome), 2 suffered from incomplete paraplegia, 2 had a Brown-Séquard syndrome and two had pure bladder dysfunction (Table III). Both the Brown-Séquard syndrome cases had other associated injuries (one had fractures of T11, T12 and L2 and the other had left clavicular fracture). On the day of discharge 6 of those with neurological deficits (3 tetraparetic, 2 paraparetic and one with bladder involvement) had recovered fully but 7 still had some residual neurological deficits; 4 had associated fractures of other vertebrae. The relatively low incidence of neurological involvement in fracture of the ring of the axis was explained by Effendi *et al*[1] using Jefferson's article.[7] He indicated that this type of fracture caused the anterior fragment to move forward and this widened the spinal canal permitting the cord to escape injury. Should there be any neurological deficit it would be mild and transient.

Since there was no satisfactory way to classify the fracture into stable and unstable types, there were contradicting views and opinions concerning the treatment of this type of lesion. Cornish[8], for example, thought the injury to be grossly unstable and he recommended stabilisation by surgery,

Table II: Aetiology

		Total	%
Vehicular accidents:	motorcyle	11	33.3
	car, lorry, truck, van	10	30.3
Industrial accidents:	falls from heights,	5	15.2
	hit by objects	1	3.0
	falls	1	3.0
Other accidents:	falls from heights	4	12.2
	falls	1	3.0
Total		33	100

Table III: Types of disability (neurological)

	On admission	On discharge
Tetraplegia/paresis	7	4
Paraplegia/paresis	2	0
Brown-Séquard syndrome	2	2
Bladder dysfunction only	2	1
No neurological deficit	20	26

with which others disagreed. In 1981 Francis and his colleagues[9] classified the injury into 5 grades according to displacement, angulation and ligamentous instability. Displacement was defined as the anterior or posterior movement of the body of the axis on that of the third cervical vertebra at the posterior edges of the bodies of the vertebrae. Angulation of the axis was measured using lines drawn on the posterior aspect of the body of the axis and of the third cervical vertebra. The fracture was considered stable when the displacement was less than 3.5 mm or the angulation was less than 11 degrees (grade 1). Grades 2 and 4 were considered to be unstable. Grade 5 meant that the displacement was more than half the saggital width of the body of the third cervical vertebra or that the angulation had produced widening at either the anterior or posterior borders of the damaged disc space greater than the height of the centre of the normal disc below (Table IV). Francis *et al*[9] treated their cases by using either cervical or cervicothoracic braces and avoided surgery unless there was established non union. Those treated by traction were divided into those on traction for 6 weeks and those on traction for less than 3 weeks and then allowed to sit up in a halo-pelvic brace.

In the same year Effendi *et al*[1] classified the lesion into 3 types. Type I fracture showed an isolated hairline fracture involving any part of the ring of the axis and the disc space below the axis was normal and stable (Fig 1). Type II fracture showed displacement of the anterior fragment either in extension, flexion or obvious forward listhesis with an abnormal disc below the axis. Type III fracture showed displacement of the anterior fragment in the flexed position and the facet joints at C2 and C3 were dislocated and locked. Type I lesion

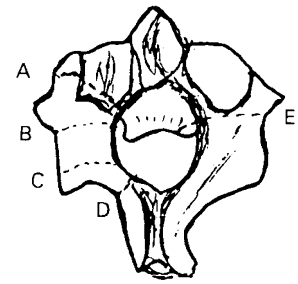

Figure 1 Axis vertebrae (Effendi *et al*).[1] Fracture may involve any part of the ring of the axis including: (1) the facet joints (A&C); (2) the pars interarticularis (B); (3) the laminae (D); and (4) part of the posterior wall of C2 vertebral body (E).

was considered as stable whereas the other two were unstable (Fig 2). Type I cases were treated by bedrest for a few days till they could confidently lift their head, after which they were allowed to get out of bed with orthopaedic braces for 6 weeks. Those with unstable type II lesions needed traction, preferably in extension with weights between 2 to 4 kgm for 3 weeks or alternatively they could use a halo-thoracic splint and be allowed to sit up earlier than 3 weeks if acceptable alignment was achieved and maintained. After 12 weeks the lesion should be assessed by stress films. If there was instability, an anterior spinal fusion of C2 and C3 should be done. For the type III lesions attempts should be made to reduce the dislocated and locked facets at C2/C3 vertebrae by manipulation and traction and, if these should fail, an open reduction should be carried out. If conservative treatment was succesful then the remainder of the treatment should be the same as for type II.

At our centre the management of Hangman's fracture is essentially conservative.

Table IV: Classification of injury (Francis *et al*[9])

Grade	Displacement	Angulation (degrees)
I	<3.5 mm	<11
II	<3.5 mm	>11
III	>3.5 mm or <0.5 vertebral width	<11
IV	>3.5 mm or <0.5 vertebral width	>11
V	Disc disruption	

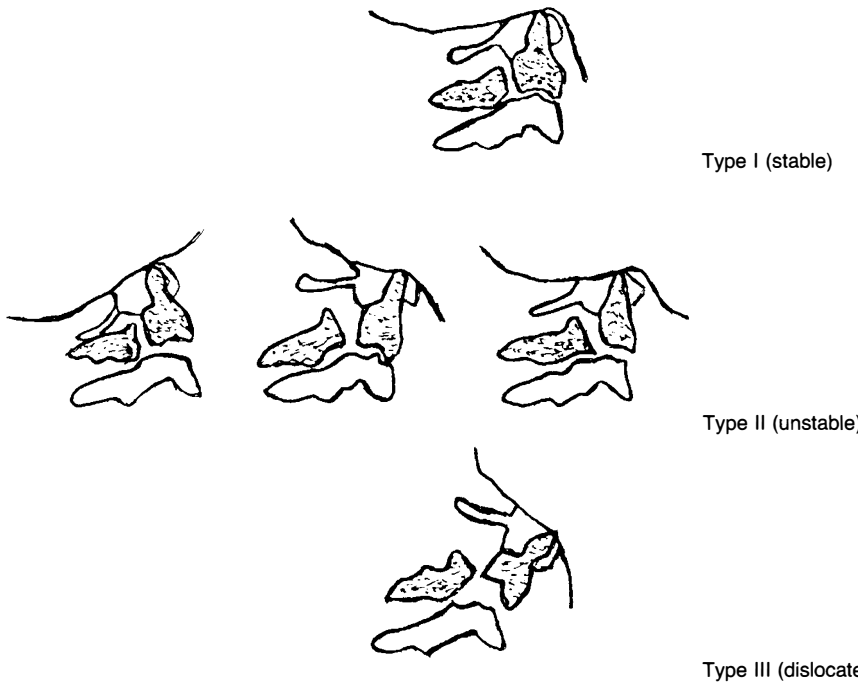

Figure 2 Classification of fracture of ring of axis (Effendi *et al*). Type I (stable), Type II (unstable), Type III (dislocated)

Once the patient is admitted to the centre, an x-ray is ordered to ensure that the fracture does not get worse during the transfer and also to guide us on the direction of the cervical traction needed to produce optimal effect. Skull traction with weights of 2 to 4 kgm for at least 6 weeks is applied in each case, and at the end of this period another x-ray is taken. The skull traction is in most cases meant to immobilise and maintain the neck in alignment rather than to distract it. At the end of this period over 90% of the 33 cases showed signs of callous formation. They are then allowed to sit up with plastozoate collars, Doll's Collars or Sterno-occipito-mandibular Immobilisers (SOMI). If there is still gross instability, traction is prolonged for a further period or cervical fusion is carried out.

Using Effendi *et al's* classification[1] there were 21 type I, 11 type II and one type III fractures. On admission 20 cases had no neurological deficits (13 type I, 6 type II and one type III). The one with a type III lesion was successfully treated by manual reduction and traction. All the 21 type I cases were fitted with pastozoate collars, 10 type II cases with Doll's collars and the one with type III lesion had a SOMI brace.

Conclusion

Patients with a fracture of the ring of the axis have a good prognosis as they seldom develop neurological deficits because, as Effendi *et al*[1], using Jefferson's[7] explanation pointed out, any fracture of the ring will cause the anterior fragment to move forward, thus widening the neural canal further to allow the spinal cord to escape injury. It is found that the causes and effect of fracture of the ring of the axis in this study remain essentially similar to those of an earlier paper published by Marar[10] on 'Fracture of the axis arch—hangman's fracture of the cervical spine—1968 to 1971'. Fracture at this site tends to heal well and over 90% of our cases showed signs of healing as early as 6 weeks after the injury. Their stay in hospital also tends to be shorter than is reported in several other series, the average stay of our patients being

7 weeks. On discharge 28 patients could return to gainful employment within one year of their injury.

Acknowledgements

The authors wish to thank the Medical Director Tan Tock Seng Hospital, Dr Ng Kwok Choy, for permission to publish this paper, and Sir George Bedbrook, Emeritus Consultant Spinal Surgeon, Royal Perth (Rehabilitation) Hospital, for vetting the paper and encouraging us to publish it. The authors are grateful to the editors and publishers of the *Journal of Bone and Joint Surgery*, 63–B, 3, 1981, 313–318 for permission to publish Figures 1 and 2.

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