Chapter 45
Traumatic Spondylolisthesis of the Axis (Hangman's Fracture)

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Description

Levine Edward Classification

This injury refers to a fracture of both pedicles or pars inter-articularis of the axis vertebra (C2) (Fig. 45.1). Apart from hangings, the mechanism of injury – a sudden forceful hyperextension centred just under the chin – occurs mainly with deceleration injuries in which the victim's face or chin strike an unyielding object with the neck in extension. The most recent and most useful classification is the four types classification proposed by Levine and Edwards, which is essentially a modification of Effendi and associates three types classification [1, 2].

Type I (**29** %)

Bilateral pedicle fractures with less than 3 mm of anterior C2 body displacement and no angulation. The mechanism of this injury is hyperextension with concomitant axial loading and a force sufficient enough to cause the fracture but not enough to disrupt the anterior longitudinal ligament (ALL), posterior longitudinal ligament (PLL), nor the C2/C3 disk. The integrity of the C2/C3 disk, ALL, and PLL determines the stability of the injury; with these elements intact, the injury is considered stable.

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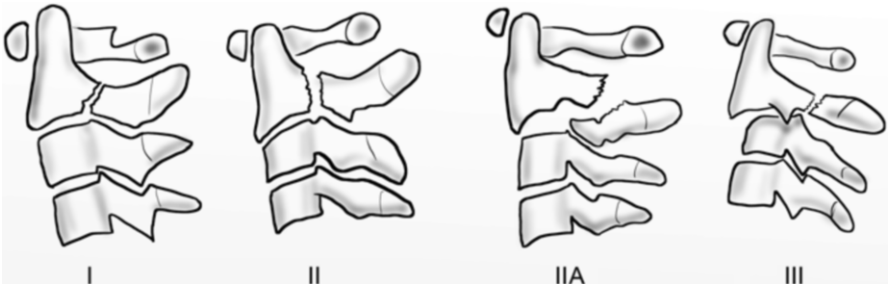

Fig. 45.1 The four types of the axis fractures according to the Levine Edwards classification system: type I bilateral pedicle fractures with <3 mm of anterior displacement; type II significant displacement and angulation; type IIA no anterior displacement but severe angulation; type III severe displacement and angulation

Type II (**56** %)
Type II fractures (56 %) demonstrate significant displacement and angulation. The mechanism of this injury is twofold: hyperextension with concomitant axial loading, followed by flexion with concomitant axial compression. The resultant injury pattern is bilateral pedicle fractures with slight disruption of the ALL and significant disruption of the PLL and C2/C3 disk. This injury is considered unstable.

Type IIA (**6** %)
Type IIA fractures (6 %) demonstrate no anterior displacement, but there is severe angulation. The mechanism for this injury is flexion with concomitant distraction. The resultant injury pattern is bilateral pedicle fractures with C2/C3 disk disruption and some degree of insult to the PLL. This is an unstable fracture. Radiographs taken while the patient is in cervical traction demonstrate an increase in the C2/C3 posterior disk space.

Type III (**9** %)
Type III fractures (9 %) demonstrate severe displacement and severe angulation. The mechanism of this injury is flexion with concomitant axial compression. The resultant injury pattern demonstrates not only bilateral pedicle fractures with C2/C3 disk disruption, but also concomitant unilateral or bilateral C2/C3 facet dislocations. Varying degrees of injury occur to the ALL and PLL. This is an unstable fracture. Mortality and morbidity are relatively high with this injury; neurologic sequelae are particularly notable.

Treatment Strategy [3, 4]

Although a hangman's fracture may be unstable, survival from this fracture is relatively common, as the fracture itself tends to expand the spinal canal at the C2 level. It is not unusual for patients to walk in for treatment and have such a fracture discovered on X-rays.

Type I Two to five days of skull traction (2–4 Kgr), followed by Philadelphia brace or cervico-thoracic brace for 6–8 weeks shall be adequate for fracture healing.

Type II Despite instability, this type of injury is rarely driven to non-union. Furthermore, even not perfect anatomic reduction rarely aggravates the functional outcome. Several treatment options are available for type II fractures, the first being external fixation with halo or tong traction in weighted extension for 1 week. If reduction is acceptable (with less than 4 mm of displacement and less than 10° of angulation), treatment progresses with halo-vest immobilization for 12–16 weeks. If reduction is unacceptable, weighted extension traction resumes for up to 6 weeks, followed by halo treatment for 6 weeks. If adequate results are not achieved after closed reduction and traction, open reduction with anterior cervical plating is the next step. The other surgical treatment option consists of weighted extension traction to accomplish adequate reduction, followed by internal fixation with a C2 transpedicular screw. Non-operative and surgical treatments typically yield excellent results.

Type IIa Type IIa, in addition to type II fracture, is characterized by widening of the posterior part of C2–C3 disk when traction is exerted. Cervical traction is contraindicated in these cases. Treatment options for type IIA fractures include both non-operative and surgical measures. Non-operative treatment consists of closed reduction that is obtained under fluoroscopic guidance via application of compression and extension and is followed by halo-vest immobilization. Repeated imaging is used to monitor the healing process with a variable time course. Surgical options include C2 transpedicular screws, anterior cervical plating and posterior C1–3 fusion. Non-operative and surgical treatments typically yield very good results. Malunion is a potential complication.

Type III Surgery is indicated if the fracture line extends anteriorly to the facet dislocation, at the level of the dislocation, or just posterior to it. Any of these locations make reduction unlikely secondary to instability. In this case, surgical reduction and stabilization is mandated and is accomplished with lateral mass plates, interspinous wiring, bilateral oblique wiring, or posterior fusion C1–3. Once accomplished, bilateral pedicle fractures can be addressed with C2 transpedicular screws, or treated non-operatively with traction or a halo/vest. Lateral mass plating of C2 by placing lateral mass screws in C3 in conjunction with C2 transpedicular screws may make postoperative halo immobilization unnecessary. For all types of traumatic spondylolisthesis fractures, nonunion and malunion are the major complications of non-operative treatment, but, fortunately, these are rare.

Hangman's axis fractures – evidence according to Levine Edwards classification			
Classification	Meta-analysis	Systematic review [5–7]	Cochrane library
Type I	Lack of evidence	Consensus for non-operative treatment (traction and external immobilization)	Lack of evidence
Type II	Lack of evidence	Consensus for non-operative treatment (traction and external immobilization)	Lack of evidence
Type IIa	Lack of evidence	Consensus for operative treatment	Lack of evidence
Type III	Lack of evidence	Consensus for operative treatment	Lack of evidence

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