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Mini Review

Guidelines on the Management of Atlanto-Axial Fractures in Adults: A Short Review

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Abstract

Fractures of upper cervical spine are very rare. The principles underlying the management of injuries to atlas and axis in adult patients are different from sub-axial spine. The current article comprehensively outlines the rationale behind the management of these injuries and discusses the guidelines based on the existing literature. A majority of these fractures can be managed conservatively. Specific indications for rigid immobilization and surgical fusion have been outlined in this article.

Fractures of Atlas

Acute atlas (C1) fractures are rare injuries, accounting for 2-13% of all cervical spine fractures [1]. Although previously described by Cooper et al in 1822, the report by Jefferson et al. in 1920 was of the greatest historic significance [2]. The greatest emphasis, as far as the management of this injury is concerned, has largely been placed on the intactness of transverse atlantal ligament (TAL) [3].

The identification of injury to this ligament has traditionally been on the basis of open-mouth radiographs [3]. However, MRI has a much greater sensitivity in identifying any underlying damage of transverse atlantal ligament [4]. The traditional diagnosis of violation of TAL was described as the Spence rule (6.9mm displacement of C1 lateral mass over C2. In 1993, Heller et al. [5] purported that 8.1 mm could be a better cut-off for identifying TAL rupture. In 1996, Dickman et al. [4] reported that in as many as 60% of patients with a negative Spence rule, an underlying TAL ligament injury could be discovered on the basis of an abnormal hyper-intense signal visualized on MR Imaging. They recommended a treatment protocol for atlas fracture on the basis of MR findings. Hein et al. [6] re-defined unstable atlas burst fractures or Jefferson fractures as fractures of anterior and posterior atlantal arches with rupture of TAL and incongruent atlanto-occipital and atlanto-axial joints.

Hadley et al. [5] proposed a treatment protocol for C1 fractures, on the basis of plain radiograph findings. They recommended initial management of C1 fractures with external immobilisation only (a majority of these fractures heal at around 12 weeks). Atlas fractures with combined lateral mass displacement (CLMD) of 6.9 mm or less were successfully managed with cervical collar. For a CMLD greater than 6.9 mm, a more rigid immobilization with halo-orthosis or sub-occipital mandibular immobilizer was recommended. A similar line of management was proposed by Fowler et al. [7]; and Levine & Edward [8]. Late instability of such conservatively-managed C1fractures, although infrequent, can occur. Therefore, careful clinical and radiological follow-up is of utmost relevance until radiological union occurs [9]. Horn et al. [10] reviewed the complications following halo-fixation in elderly patients (>70 years) and reported that halo immobilization was a safe procedure in these patients. Nevertheless, he cautioned about the higher incidence of complication rates associated with halo-vest immobilization in this population, as compared to younger patients (respiratory distress–9.5%, dysphagia–14.3% and pin-related complications – 23.8%).

In the post-MRI era, Lee et al. [11] classified the atlas fractures into three types: anterior or posterior arch fractures (Type 1), burst fractures (Type 2) and lateral mass fractures (Type 3). Type 1 and 3 fractures were considered stable and treated with rigid collar immobilisation. Type 2 fractures were further classified on the basis of associated TAL injury (diagnosed on LCMD > 7mm or pre-dental interval >5mm or TAL rupture on MR Imaging). C1-2 fusion has been reported as treatment in such unstable pattern of type 2 injury. Another important consideration that should be kept in mind, before planning the management of TAL injuries is the actual location of ligament failure. Fractures with intra-substance rupture of TAL (Type 1 injury) are highly unstable and need to be considered for early surgical treatment. A TAL failure with a bony avulsion is relatively more stable and can potentially be managed with external immobilization [4].

Fractures of Axis

Odontoid fractures

Anderson & Alonzo [12] classified odontoid fractures into three types: type 1 involving avulsion fracture of tip of odontoid,

type 2 across the base of dens near the junction with body; and type 3 involving the body of axis. Grauer et al. [13] further sub-classified type 2 fractures into: 2A –involving minimal or no displacement or comminution, 2B –involving displaced fracture extending antero-superior to postero-inferiorly or transverse fracture, amenable to anterior screw fixation; and 2C – extending from antero-inferior to posterior-superior direction or fracture with significant comminution, which are amenable to posterior fusion. Type 2C fractures respond less satisfactorily to conservative modalities of treatment [13]. Overall evidence suggests that the intial, recommended management in type 1, most of type 2 and type 3 fractures is external immobilization [14,15]. There is a current recommendation for early surgical stabilisation and fusion for type fractures in patients older than 50 years [14-16]. Surgical stabilisation and fusion of types 2 and 3 odontoid fractures is recommended when the displacement is more than 5 mm, fracture is comminuted or it is difficult to maintain reduction with an external immobilization modality [16].

The options for conservative management include cervical traction (union rates reported in the literature of around 100% in type1, 43% in type 2 and 87% in type 3 fractures), cervical collar (100% union rates in type1, 53-57% in type2 and 50-65% in type 3 fractures) and halo-immobilization, including custom devices including suboccipitomandibular brace and Minerva devices (100% union rates for type 1, 72% for type 2 and 99% for type 3 fracture) [16,17]. The operative options for odontoid type 2 fractures include anterior screw fixation and posterior C1-2 fusion. Posterior C1-2 fusion is the modality of choice in type 2C injuries, old injuries not amenable to reduction and elderly patients especially with poor bone stock [17]. In the elderly patients with odontoid fractures, the ability to tolerate halo-immobilization is highly questionable; and mortality rates as high as 26% have been reported [16,18]. Frangen et al. [18] recommended early surgical intervention, in the form of posterior C1-2 fusion for the elderly patients.

Hangman fracture

The well-accepted classification scheme for traumatic spondylolisthesis of the axis was proposed by Effendi et al. [19], which included three types: type 1: isolated harline fracture (less than 3mm displacement) of the ring of axis with minimal displacement (more than 3mm displacement) of C2 body (axial loading+hyperextension injury), type 2: fractures of ring of axis wit displacement and C2-3 disc space disruption (hyperextension+rebound flexion); and type 3: fractures of ring of axis with displacement, flexed angulation and C2-3 facet dislocation of axis vertebra (flexion + rebound extension). Levine & Edward [20] modified the Effendi classification system and proposed flexion distraction as another mechanism of injury. Type 2 was thus described as >3mm displacement and significant angulation of the anterior fragment, while 2A was described as severe angulation with minimal (< 3 mm) displacement (flexion-distraction).

The initial management of most types of Hangman fractures is typically non-surgical, with high success rates [21]. The major factor to be considered in decision making is possibly the instability at C2-3 level. Based on the systematic review by Li et al. [21] non-rigid external immobilization may be sufficient in most Levine Edwards type 1 and 2 injuries, traction followed by external immobilization may be used in Levine Edwards type 2 fractures, while more rigid immobilization or surgical fusion should be considered for Levine Edwards types 2A and 3 injuries. It has also been reported that halo-immobilization does not always achieve or maintain immobilization, and there is an occasional need for surgical fusion in this sub-group of patients [22,23]. Multiple complications are also known to occur with halo-immobilization including pin loosening, infection, cranial fractures, poor compliance, chest infections, complications secondary to long time patient immobilization like pressure sores and deep venous thrombosis [21,23].

Axis Body Fractures

These are exceedingly rare fractures [24]. Benzel et al. [24] classified C2 body fractures into three types: type 1: coronal, type 2: sagittal and type 3: transverse fractures. Most of these fractures are managed conservatively [25]. In the study by Greene et al. [14], [25], 99% of axis body fractures were treated conservatively with external immobilization. Many of these fractures extend into the transverse foramen and are associated with vertebral artery injuries [26]. Korres et al. [27] described a multiple atlas fracture pattern in 1% of patients. All patients with C2 fracture therefore need CT scan evaluation.

Combination fractures of atlas and axis

Owing to the unique bony anatomy of atlas and axis, combination fractures of these bones is not uncommon [28]. In the legendary study by Geoffrey et al. [29], 19 of the total 46 atlas fractures were actually combination fractures of these two bones. The incidence of concomitant injuries to C1 and odontoid process ranges from 5-53%, while incidence of combination atlas and Hangman fractures ranges from 6 to 26% [30]. The usual combination injuries reported in the literature include combined bi-pedicular fracture of C2 with odontoid fracture, C1 posterior arch fracture with odontoid fracture, Jefferson fracture with odontoid fracture and C2 articular pillar fracture with odontoid fracture [30]. The incidence of neurological injury is also reported to be higher in combination injuries, as compared with isolated atlas or axis fractures [31].

Levine & Edward [32] suggested that these combination fractures are best managed sequentially, allowing the atlas (in most situations) to heal first followed by attempting to definitively manage C2 injury. The treatment of these injuries typically is based on the characteristics of C2 fracture. The management options include traction followed by immobilization, semirigid immobilization with cervical collar, rigid immobilization with halo, Minerva, sterno-occipito-mandibular immobilizer, posterior C1-2 fusion and anterior odontoid screw fixation [33]. Longo et al. [34] in a systematic review on halo immobilization, concluded that halo immobilization is a safe and effective treatment modality in combination injuries.

Conservative management with external immobilization (cervical collar or cervical traction with halo immobilization) is

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sufficient in most cases (approximate healing in 12 weeks) [35]. The two most controversial situations include C1-type 2 odontoid and C1-Hangman fracture combinations. Immobilization with halo or surgical fusion should be considered in unstable C1-type 2 odontoid fractures, which may be defined as atlanto-dens interval of 5 mm or more [36]. Similarly, rigid halo immobilization or surgical fusion needs to be considered in unstable C1-Hangmen fracture combinations with C2-3 angulation of 11° or more [37,38].

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