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Original Article

Conservative management of craniovertebral junction injuries: Still a good option

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Abstract

Background: Injuries to the craniovertebral junction (CVJ) are not uncommon, and are among the few skeletal injuries that carry a high mortality rate. Successful management of these injuries depends on familiarity with the normal anatomic relationships of this region, as well as prudent decision making regarding surgical versus conservative management alternatives.

Methods: The purpose of this study was to analyze the indications for conservative treatment of CVJ trauma and to analyze the outcomes.

Results: Eighty-eight patients admitted with CVJ injuries were managed conservatively. More than half were nearly neurologically intact on admission; 91% improved whereas 80% (excluding deaths/lost to follow) ultimately achieved bony union without surgical intervention.

Conclusion: This study documents that conservative management of CVJ injuries in a select population can yield good clinical results.

Key Words: Atlanto-axial subluxation, C1 fracture, C2 fracture, craniovertebral junction (CVJ), odontoid fracture

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INTRODUCTION

Here, we reviewed our experience at one institution with 88 patients with craniovertebral junction (CVJ) trauma treated nonsurgically over a 10-year period. Notably, injuries to the CVJ are not uncommon, and are among the few skeletal injuries that carry high mortality rates.[1] Trauma constitutes approximately 25–30% of cervical spine injuries, and 25–40% of the patients with CVJ injuries die at the scene of an accident.[4] Nevertheless, neurological morbidity tends to be low in those who survive these traumatic events.[4]

This study analyzed the indications and outcome of conservative management with immobilization of 88 individuals, as well as correlated the clinical presentation and radiographic findings with nonsurgical treatment options.

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MATERIALS AND METHODS

All 88 patients who presented with CVJ trauma admitted to Neurosurgery department at the SKIMS Kashmir (2005–2014) and were managed conservatively were included in this study.

The patients were resuscitated immediately and immobilized by a rigid cervical collar. They subsequently underwent radiographic investigation (e.g., anterioposterior, lateral, and oblique cervical X-rays). Those demonstrating X-ray evidence of fracture/dislocation and or with neurological deficits additionally had computed tomography (CT) scans (including three-dimensional reconstructions); moreover, cervical magnetic resonance (MR) studies were performed. MRI is definitely better than CT scan in evaluating the status of ligaments and cord.[6] It remains our preference to defer any motion studies until a patient has no cognitive impairment or has decreased neck tenderness. The following criteria were utilized to plan the management for these patients. First, axis fractures managed conservatively had anterior or posterior arch fracture only, with intact transverse ligament or fracture of lateral mass or transverse process only [Figure 1]. Second, atlas (C2) fractures, including odontoid fractures [Figure 2] Hangman's fracture [Figure 3a and b], and C2 miscellaneous fractures [Figure 4], who had displacement less than 5 mm, absence of transverse ligament disruption, no notable movement at fracture site, and absence of nonunion by the 14th week were managed conservatively. Cases of atlantoaxial dislocation (AAD) with irreducible subluxation, atlantodental interval >3 mm, and notable displacement on dynamic imaging at 3 months were not considered for conservative management. Patients underwent follow-up neurological examinations and had repeat imaging for examining union vs. nonunion, with an added assessment of alignment. Patients were assigned a modified Rankin's outcome score (mROS) to facilitate analysis of long-term outcomes.[3]

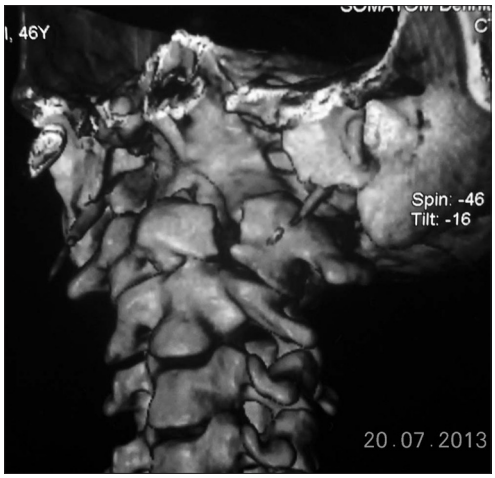

Figure 1: CT with 3D reconstruction showing fracture of the posterior arch of C1

Clinical features of 88 patients with craniovertebral trauma

This population included mostly young males aged 21–40 years old (50%). A fall was the most common mode of trauma (61.3%). Notably, 47.7% patients were neurologically intact. Alternatively, 61% were quadriplegia/quadriparetic [Table 1]. Fractures were seen in 82 patients, and dislocations in 6 patients without fractures. Odontoid fractures were the most common injuries in 54.5%; type II was present in 47.7% of cases. AAD was the most common type of subluxation seen (29.5%; n = 26) [Table 2]. Causes of trauma mostly included falls leading to C2 injuries (59.1%) with attendant dislocations in 20.5% of the patients. Assaults resulted in C1 fractures (2.2%) or dislocations in 2.2% [Table 2].

Table 1: Demographic profile of patients with CV junction trauma

Demographic profile of patients	Number of patients	Percentage
Mode of injury		
Fall from height	62	(61.3)
Road traffic accidents	14	(16)
Assault	4	(4.5)
Fall of objects on head and neck	6	(6.8)
Others	2	(2.25)
Neuro-deficits		
No deficit	42	(43.1)
Motor power loss	26	(29.5)
Sensory + motor loss	20	(22.7)
Motor impairment pattern	46 patients	
Quadriparesis/plegia	28	(60.8)
Hepiparesis/plegia	5	(10.8)
Only upper limb weakness	7	(15.2)
Only lower limb weakness	2	(4.3)
Monoparesis/plegia	4	(8.7)

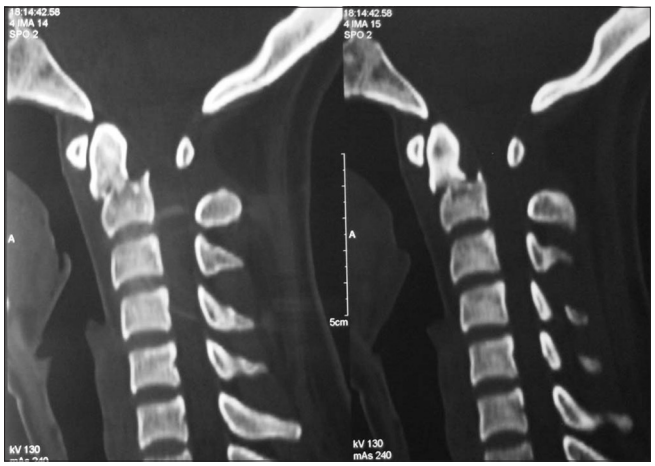

Figure 2: CT showing type II odontoid fracture

Table 2: Distribution of patients according to type of fracture/dislocation at CVJ (*N*=88)

Type of Vertebral Injury	Number/Percentage	Cause of trauma				
		Fall	Road accidents	Assault	Fall of object on H/N	Others
C1 # (arch, lateral mass, Jefferson's)	8 (9.1)	6 (6.8%)	-	1 (2.2%)	1 (2.2)	-
C2 parsinterarticularis # (Hangman's)	6 (6.82)					
C2-odontoid #						
Type I	6 (6.82)	52 (59.1%)	14 (15.9%)	1 (2.2%)	5 (5.5%)	2 (2.2)
Type II	42 (47.7)					
Type III	0					
C2 misc (body, spinous process, lamina, facets)	20 (22.7)					
Atlanto-Axial dislocation (AAD)	26 (29.5)	18 (20.%)	6 (6.5%)	2 (2.2%)	-	-
Occipito-atlantal dislocation (OAD)	0			0		

H/N: Head/neck

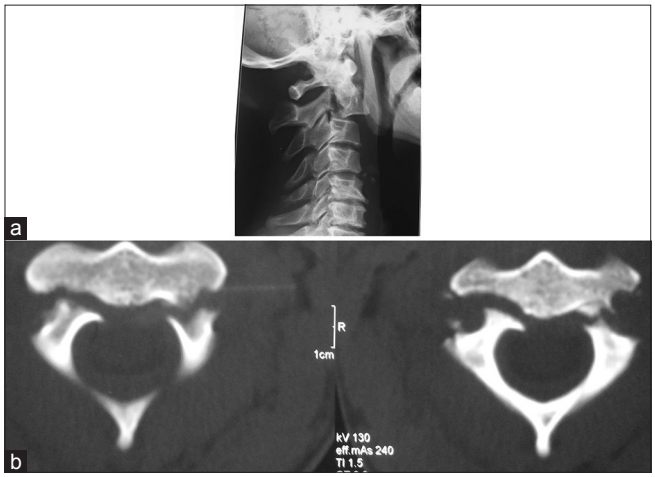

Figure 3: (a) Hangman's fracture (bilateral pars interarticularis fracture) on X-ray image. (b) Axial CT showing Hangman's fracture (parsinterarticularis fracture)

Figure 4: CT showing vertical fracture of C2 body

X-Rays were less reliable that CT studies in documenting pathology at the CVJ. Notably, X-rays identified fractures in just 73.6% of the patients, and subluxation in 84.6% patients. Alternatively, CT identified fractures in 97.5% of the patients and subluxation in 92.3%. MR studies also showed evidence of cord injury (e.g., edema, contusion, hematoma) with signal changes detected in 32 patients (36.3%), whereas 56 (67.7%) patients had no sign of cord injury.

All 88 patients were managed conservatively for C1 fracture (100%), Hangman's 66.6%, Odontoid type I 100%, type II 20%, and AAD 12%. Out of the 88 cases, 80 were treated with a Philadelphia collar primarily or following cervical traction, whereas 8 required halo-braces.

RESULTS

Out of the 88 cases, 80 (90.9%) improved, 4 (4.5%) did not improve, none deteriorated, and 4 (4.5%) died. With regards to initial motor weakness, all patients with power grade III and above showed improvement (100%). Out of 8 patients who had grade 0 power on admission, 4 patients (50%) improved whereas 2 (25%) did not improve and died. On follow-up radiology, 80.5% (58/72) achieved fusion, 13.8% (10/72) had nonunion, and 5.5% (4/72) had malunion by 6 months. For 16 patients, 6-month radiology was unavailable as 12 patients were lost to follow-up (13.6%) and 4 (4.45%) died [Table 3]. Patients categorized by mROS score, on follow up, 36 (42.8%), 28 (33.3%), and 8 (9.5%) patients had scores 0, 1, and 2, respectively, [Table 3].

DISCUSSION

Injuries of CVJ are potentially fatal due to close proximity of vital structures such as brainstem, upper cord, and vertebral arteries. Moreover, this region's vulnerability to injury is particularly high because of the large lever-arm induced rostrally by the cranium and the relative freedom of movement of the CVJ, which relies disproportionately on ligamentous structures rather than on intrinsic bony stability.

Table 3: Outcome, mortality and Rankin's outcome score of 88 patients

Outcome profiles of patients	Number/percentage of patients
Outcome & Mortality	
Improved	80/88 (90.9%)
Not improved	4/88 (4.5%)
Deteriorated	0
Deaths	4/88 (4.5%)
Follow-up Radiology	
Union achieved*	58/72 (80.5%)
Non union*	10/72 (13.8%)
Mal-union*	4/72 (5.5%)
Lost to follow up and deaths	16/88 (13.6%) (12+4)
Modified Rankin's outcome score scale	
Rankin-0 (No symptoms/signs)	36 (42.8%)
Rankin 1 (Symptoms but no disability)	28 (33.3%)
Rankin 2 (Slight disability)	8 (9.5%)
Rankin 3 (Moderate disability)	4 (4.7%)
Rankin 4 (Moderate-severe disability)	8 (9.5%)
Rankin 5 (Severe disability)	0
Deaths	4 (4.7%)

Here, we reviewed our experience at one institution with 88 patients with CVJ trauma treated nonsurgically over a 10-year period. Literature reports that road traffic accidents are the most common mode of injury worldwide (70%),[3] however, in our series, most injuries were due to fall from fruit trees, house roof, mountain slopes, and slippage on snow (61.3%). 52.2% patients had neurodeficit at presentation whereas 47.7% had no deficit; however, in literature, neurological compromise is seen in 5–10% of the cases only, which is significantly less than that in our study.[3] The reason for this discrepancy is referral pattern, which implies that only those with neurological deficits tend to get referred, as well as misinterpretation of radiology and incomplete reports from small centers. Moreover, patients in this region visit health centers only if they develop noticeable neurodeficit. We tried to find a correlation between mode of trauma and level of injury [Table 2], which was not considered in any previous studies on CVJ trauma.

Atlas fractures seen in 8 (9.1%) patients [Figure 1] and type-I odontoid fractures were given Philadelphia collar and Halo brace and all improved. Studies reveal 90% of C1 and type-I odontoid fractures achieve successful fusion conservatively.[7] Only20% of type II [Figure 2] odontoid fractures were managed conservatively. Authors advocate conservative approach in selected cases and early surgery if axis fractures could not be maintained by external orthosis, ruptured transverse ligament, those with 6 mm or more of dense displacement, and comminuted dense fractures.[5] Among C2 miscellaneous fractures [Figure 4], 90% were successfully managed conservatively and only 2 patients with associated C3 injury had to be operated.

Nonoperative treatment options consist of recumbent skeletal traction, bracing (Philadelphia collar and halo), and immobilization. The duration of external immobilization usually ranges from 2 to 4 months.[2] 88.6% patients were managed with Philadelphia collar and 11.3% with halo-vest brace. The average duration of halo vest application was for 12 weeks. The disadvantage of halo was psychological adjustment and restriction of movements, unavailability of device, poor patient compliance, and higher cost. Various authors have suggested that, for the nonoperative management of odontoid fractures, halo device has higher documented success rates.[2]

Among the conservative group, 90.9% improved, 4.5% did not improve and none deteriorated [Table 3]. Compared with operated patients during this period, improvement was seen in 77.2%, no improvement in 13.6%, and 9.09% had worsening of neurological status. The apparent better outcome in the conservative group may be due to the fact that surgery was done in patients with more complex injuries and poor neurological status at the time of presentation. All the patients with power grade III, IV, and V on admission improved (100%) and 75% with initial grade 0, I, and II motor power improved.

In conservatively treated cases, fusion and nonunion rates were quite similar to operated cases; follow-up radiology revealed that 80.5% achieved fusion, 13.8% had nonunion, and 5.5% had malunion. In cases operated during this period, 81.8% achieved fusion, 4.5% had nonunion, and 9.09% had malunion [Table 3]. According to the literature, surgical intervention is reserved for nonunion of the fracture or the presence of atlantoaxial instability after an adequate trial of nonoperative management.[7] Slightly poor nonunion rates after conservative trials may be due to the use of less rigid collars, allowing some movement at the fracture site compared to highly stable fixation instrumentation in operated cases. Nonunion rate (radiological) although higher in conservative group was not associated with neurological deterioration clinically.

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Conflicts of interest
There are no conflicts of interest.

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