



# International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2021; 7(4): 542-546  
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[www.orthopaper.com](http://www.orthopaper.com)  
Received: 10-08-2021  
Accepted: 12-09-2021

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## Stabilization does not guarantee neurological recovery but prevents deterioration in the management of AO type-B Sub axial cervical spine injuries: 15 years clinic- radiological outcome from a retrospective cohort analysis

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DOI: <https://doi.org/10.22271/ortho.2021.v7.i4h.2930>

### Abstract

**Study Design:** Retrospective cohort analysis.

**Purpose:** To evaluate the long-term clinical and radiological outcome of AO type-B Sub axial cervical spine fractures managed with combined anterior and posterior spinal fusion.

**Overview of Literature:** AO Type-B sub axial Cervical fractures involve disruption of the anterior column and posterior tension band osteoligamentous complex. Such injuries demand early surgical management with effective reduction and fusion of the involved vertebra. Though different methods of reduction and surgical approaches have been published in the literature, we preferred global stabilization and fusion and evaluated their long-term outcome.

**Methods:** We retrospectively evaluated 22 patients with post-traumatic unstable sub axial cervical spine injuries which got treated from 2006-2008 with their preoperative clinical details, radiographs, computed tomography, and magnetic resonance imaging of the cervical spine. All patients were managed by immediate reduction, posterior and anterior stabilization, and fusion in a single session of anesthesia. Data of all patients were analyzed with respect to the status of fusion, pre-and post-operative neurological status based on Frenkel staging, along with their complications.

**Results:** The mean age of the included patients was  $32.9 \pm 12.14$  years, with M:F ratio of 21:1. The average length of hospitalization was  $20 \pm 12.63$  days. All patients achieved fusion at a mean period of  $4 \pm 1.45$  months. Among the included 22 patients, only 68.18% (n=15) patients improved from their pre-operative stage whereas the remaining 7 patients did not show any significant improvement in their clinical-grade since injury despite achieving solid fusion at the operated levels at a mean follow-up period of  $15.42 \pm 1.43$  years. No major complications were noted in the included patients. None of the patients showed deterioration in their clinical-grade although 2 patients died in the follow-up period.

**Conclusions:** In AO type-B sub axial cervical injuries, global stabilization and fusion in a single sitting is a viable option in surgical management without major complications. Although the procedure achieves fusion at the intended level, it does not guarantee neurological recovery.

**Keywords:** AO type-B sub axial cervical injuries, cervical spine, global fusion, frankel grade

### Introduction

More than 50,000 spinal fractures are occurring per year worldwide, among these nearly 75% occur in the cervical spine. Of them, 20% of cases are associated with fracture-dislocations and spinal cord injury [1]. These fractures are mostly due to high energy trauma which often results in disruption of various stabilizing structures around the cervical vertebrae. According to AO classification type-B, sub axial cervical fractures are due to distraction and compression forces causing failure of tension bands and fractures involving osseo-ligamentous complex producing unstable nature. Such injuries require immediate decompression, reduction, and realignment of the cervical spine with proper surgical technique and approach [2]. However, the method of surgical management remains controversial despite advances in various strategies in the fixation of the cervical spine [3].

In our study, we aimed to evaluate the long-term clinical and radiological outcomes of AO Type-B sub axial cervical fractures which were surgically managed with global stabilization and fusion.

**Materials and Methods**

We retrospectively evaluated 22 patients who presented to our hospital with unstable cervical spine injuries during the period of 2005 – 2007. The patients included in our study were those with AO Type-B sub axial cervical spine fractures with or without neurological involvement. We collected the demographic data of patients from the electronic medical records and followed them up for their current clinical, radiological, and neurological status. We also assessed the

incidence of complications. We collected data such as preoperative radiological films, preoperative neurological status from the case records. All the patients who presented with AO Type-B sub axial cervical spine injury were initially treated with skeletal traction, then they were surgically treated with single staged global stabilization and fusion. All patients were monitored in the intensive care unit postoperatively. The patients were later mobilized with a soft cervical collar for the next 3 months. All patients underwent aggressive physiotherapy for up to 1 year. Their periodic assessment records at 1, 6 months, 1 year, and 2 years were also retrieved for analysis. Improvement was evaluated with Frenkel grading as shown in Table 1 and compared with their preoperative status.

**Table 1:** Frankel grading

A	Complete injury, No motor or sensory functions below the level of injury
B	Incomplete injury, no motor function
C	Incomplete injury, motor function useless sensory incomplete
D	Incomplete injury, moto function useful sensory incomplete
E	Incomplete injury, motor normal sensory normal

The statistical analysis was performed with IBM SPSS Version 25 (Chicago, Illinois, USA). Continuous variables were presented with mean and standard deviation whereas categorical variables were presented with percentages.

**Results**

Male predominance was noted in our study with M:F ratio of 21:1. The average age of the included patients was 32.9±12.14 years, the average length of hospitalization was 20±12.63 days. The data collected from the retrospective case records were presented in Table 2. RTA was the predominant mode of injury in 14/22 patients, and 8 patients had a history of falls from height. On analysis of the regional distribution of fractures, 12 patients had an injury at C5 C6 level, 7 patients at C6 C7 level, 3 patients at C4 C5 level (86% involving C5-C7 level). The pre-operative neurological status according to Frankel grading and their current improvement was given in Table 2. 16 patients were in Frankel grade C [73%], 1 patient

of grade E, 2 patients in grade B, and 3 patients in Grade A. 16 patients were operated with the posterior first approach followed by anterior approach while 6 patients had vice versa. Among 22 patients, 15 patients (68.18%) got neurological recovery and improved from their pre-operative Frankel grading but 7 patients did not show any improvement from their preoperative Frankel grades. At a mean follow-up period of 15.42±1.43 years, 1 patient improved from Frankel - A grade to Frankel – B, 2 patients had improvement from Frankel -A to Frankel -C, one of the patients with Frankel B showed improvement to Frankel D while the other recovered completely to Frankel E. 5 patients had improvement from Frankel - C to Frankel -D and Franke -E respectively. Despite using unicortical screws anteriorly in H-plates there was no case of screw backing out or implant failure noticed in our study. The average duration required to achieve fusion was 4±1.45 months.

**Table 2:** Characteristics of the included patients in the study

Sl. No	Age/ Sex	Mode of injury	Diagnosis	Procedure Done	First approach	Complications	Neurological Improvement	Pre-op grading	Post-op grading	Follow up duration (years)
1	30/M	Fall from height	C5C6 subluxation	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Died after 3 months not related to surgery	Yes	A	B	15.3
2	55/M	Fall from tree	C5C6 subluxation	LMF with BG-P Discectomy with BG With H-Planting A	Posterior	Nil	Yes	C	E	14.5
3	23/M	Fall from height	C4C5 subluxation with C5compression #	LMF with BG-P C5 partial corpectomy Discectomy with BG with H-planting A	Posterior	Nil	No	C	C	14.4
4	28/M	Fall from tree	C4C5 subluxation with C4 lamina #	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	C	E	14.7
5	32/M	RTA	C5C6 subluxation with C5 body #	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Wound dehiscence managed conservatively	NA	E	E	15.2
6	21/M	Fall from height	C5C6 subluxation with C5 lamina#	LMF with BG-P Discectomy with BG with H-Planting A	Anterior	Nil	Yes	C	E	14.1
7	13/M	Fall from height	C6C7 # with C6 lamina #	LMF with BG-P Discectomy with BG-A	Posterior	Nil	No	C	C	15.3
8	47/M	RTA	C5C6 subluxation	Discectomy with BG with H-Planting A LMF with BG-P	Anterior	Nil	Yes	C	E	15.8
9	38/M	RTA	C6C7 subluxation with b/1 locked facets	Bony bridge excised first Discectomy with H-Plating-A LMF with BG-P	Anterior	Died of Aspiration pneumonia dies after 3 months of	Yes	C	E	14.8

						surgery				
10	25/M	RTA	Burst # C5 with b/l lamina # C5	C5 corpectomy with BG with H-Plating A LMF with BG-P	Anterior	Nil	Yes	A	C	15.5
11	32/M	RTA	C6C7 subluxation with b/l locked facets	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	B	E	15.5
12	45/M	Fall from height	C5C6 Subluxation with locked facet with # C5 spinous process	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	C	D	15.5
13	52/M	Fall from height	C3C3 Subluxation with C3 inferior facet #	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	C	D	15.9
14	59/M	Fall from height	C4C5 Subluxed with locked right facet	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	C	D	16.2
15	24/M	RTA	C4C5 Subluxation with C2C3 instability	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	No	C	C	16.4
16	19/F	RTA	#C5 body and lamina with retrolisthesis	Discectomy with C5 corpectomy with BG with H-Plating -A LMF with BG-P	Anterior	Nil	Yes	A	C	14.9
17	28/M	RTA	C5C6 subluxation with C5#	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	C	D	15.8
18	33/M	RTA	C5C6 subluxation with C6#	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	No	C	C	14.4
19	40/M	RTA	C7D1 subluxation	Discectomy with BG with H-Plating -A LMF with BG-P	Anterior	Nil	Yes	B	D	15.6
20	20/M	RTA	C5C6 subluxation with C5#	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	No	C	C	15.5
21	25/M	Fall from height	C4C5 subluxation	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	Yes	C	D	15.5
22	35/M	Fall from height	C5C6 subluxation with C6#	LMF with BG-P Discectomy with BG with H-Planting A	Posterior	Nil	No	C	C	14.7

LMF- Lateral mass fixation; BG-A - Anterior bone grafting; BG-P- Posterior bone grafting; NA – not applicable; RTA – road traffic accident

Postoperatively 1 patient had posterior wound dehiscence, which was treated conservatively. 1 patient had a sacral sore, which was treated by flap cover. Two patients expired in our study, 30/M who had C5C6 subluxation with Frankel grade A was stabilized and improved to Frankel grade B in the immediate postoperative period. He was discharged. He died after 3 months in his native place. Another patient 38/M who had C6C7 subluxation with Frankel grade C was stabilized and improved to Frankel D in the immediate post-operative period. During the hospitalization period he developed aspiration pneumonitis which was treated efficiently. But he died 3 months after surgery.

**Table 2:** Clinical improvement in the included patients

Pre-operative Frankel Grade		Post-operative Frankel Grade				
		A	B	C	D	E
A	3	-	1	2	-	-
B	2	-	-	-	1	1
C	16	-	-	6	5	5
D	0	-	-	-	-	-
E	1	-	-	-	-	1

**Discussion**

Sub axial cervical spine injuries are unstable fractures that mostly occur due to high-velocity road traffic accidents and fall from height [4]. Among 22 patients, 14 patients had Road traffic accidents (63.5%). All these patients were associated with some degree of neurological deficit. Though there are many classifications like Allen *et al.* [5], ABCD classification [6], AO classification of sub axial cervical fractures [7], we classified these fractures by the AO system of classification.

This classification considers the mechanism of injury along with the status of the osseoligamentous complex which helps to determine the appropriate plan of management. In addition to radiographs, we did Computed Tomography and Magnetic resonance imaging of affected vertebra in all patients because CT scan detects 97%–100% of fractures, and MRI is useful in assessing the intervertebral disc status, ligamentous structures which helped us to plan the management and initial trauma to the spinal cord. For instance, in patients with fractures associated with disc extrusion, we did initially anterior decompression followed by posterior stabilization [2]. Despite various studies and advances, there is no single accepted management strategy to treat sub-axial cervical spine injuries because it mostly depends on the surgeon’s discretion of assessment of the injury and the classification utilized to plan the management. Although there exists a variety of methods to manage the injury, the ultimate aim of the management is to achieve stabilization but whether that guarantees clinic-neurological improvement regains a question of debate. As far as the level of such injuries is concerned, nearly 85% of injuries were around the C5 and C7 levels. In other similar studies also >50% of injuries are located between C5 and C7 [9]. Among 22 patients, 4 sustained complete cord injuries, whereas 18 had incomplete cord injuries. Most of these unstable fractures were associated with a neurological deficit which mandates them to be surgically managed to achieve proper spinal reduction and decompression of the spinal canal with fusion to prevent further deterioration due to unstable segments [2]. There are various methods of reduction and surgical approaches that have been published in the literature without a uniform consensus in the management algorithm [2].

Lifeso *et al.* [10] and Laus *et al.* [11] in their analysis studied the management of unstable cervical spine injuries by anterior approach alone with fusion. According to Reindl *et al.* [12], additional posterior stabilization was mandated to address the irreducible fractures and cases with fractures of posterior elements, or those cases associated with disc extrusion. Combined anterior and posterior approach with global stabilization also tried for unstable cervical spine fractures [3]. In our group of 22 patients, 18 patients had flexion distraction type of injury, in which injury initially originates from the posterior structures and traveling toward anterior producing fracture of the vertebral body thereby making cervical spine unstable. This makes the posterior approach with the reconstruction of tension band very essential to prevent distraction of posterior elements thereby increasing the stability of the anterior part of the cervical spine and intermediate supporting cage during flexion movements of the cervical spine. This combined approach made us do early mobilization of the patient [3].

In our procedures, the first patient was placed on a striker's turning frame and skeletal tong with weight was maintained before induction of anesthesia. Endotracheal intubation was then accomplished in a neutral position of the neck. Then the patient was turned prone in the frame. Through the posterior midline approach [13] facetal subluxation is reduced, lateral mass fixation is done with reconstruction plates and cortical screws by Roy Camille technique [14]. After stabilization, the patient was turned supine in the same frame. While the patient was turned, the cervical traction was maintained in the neutral position. Through Southwick - Robinson approach [15] anterior decompression and fusion with tricortical iliac crest graft and anterior stabilization<sup>3</sup> with H-plates and cortical screws [16] were done. Despite following a right-sided approach, we did not encounter complications related to the recurrent laryngeal nerve in our study.

In our study, we approached 16 cases first posteriorly to achieve a direct reduction of facetal dislocation to prevent the anterior column from distracting during anterior segment fixation. Anterior decompression was done comfortably once posterior alignment is obtained which also helped in harvesting any loose fractures fragments of the lamina which were used as graft along with cage for anterior fusion, thereby preventing us from harvesting iliac crest autologous graft in a few cases. Traditionally, anterior decompression and fusion are done first after which the patient is treated for 7 to 10 days with skeletal traction. Then posterior stabilization and arthrodesis are performed as a second-stage procedure. According to McAfee & Bohlman [17], one of the major disadvantages of this traditional two-stage approach is that it necessitates an additional 7 to 10 days of hospitalization during which the patient is recumbent in skeletal traction and has an unstable cervical spine. Another disadvantage is that it requires two separate anesthetic intubations and extubations [18]. There is often some difficulty in performing the intubation or in timing the extubation of patients who have an unstable cervical spine and long post-operative stay. With global stabilization in a single anesthetic sitting we had an average hospital stay of 20±12.63 days.

In the remaining 6 cases, we started with the anterior approach to remove the offending disc and then did fusion [19]. We did not encounter any anesthesia-related complications in our study. The total duration of our surgery including positioning was calculated to be around 3.52±1.13 hours which in the study by McAfee & Bohlman took 6.9 hours [17]. The major advantages of the combined approach remain a

single anesthetic exposure with a shorter hospital stay. With regards to the method of fixation of these unstable sub-axial spine injuries, global stabilization stands out to be a viable option that achieves stable fusion in all the patients in whom it has been employed without major complications. Although surgical stabilization prevented further deterioration of the neurological status of the patient, it does not guarantee neurological recovery in all the patients since it largely depends on the primary impact of injury to the spinal cord [20]. The small sample size of the followed population is a limitation to the current study. Hence, we recommend studies with a large patient population to validate the results of our study.

## Conclusions

The AO type B sub axial cervical spine fractures with anterior column and posterior tension band complex disruption could be effectively managed by global stabilization and fusion in a single session of anesthesia, providing good results in reduction, and fusion. However, fusion achieved in these patients does not guarantee neurological recovery which largely depends on the initial injury to the cord.

The authors do not have any potential conflicts of interest to disclose.

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