

Instrumentation in cervical spine injury: neurological outcome measurement using ASIA impairment scale

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ABSTRACT

Cervical spinal cord injuries make up more than half of all spinal cord injuries. It affects 2–3% of all trauma patients and accounts for 8.2% of all trauma related deaths. Cervical spine surgery has been evolving in terms of surgical technique, equipment, and instrumentation. We have analyzed a series of patients with cervical spine injuries stabilized with various instrumentation techniques. The objective of the study was to evaluate the outcome of instrumentation in cervical spine injury measured on ASIA Impairment Scale. We present prospective observational descriptive analysis, for 36 patients, looking at the clinical and neurological outcomes following instrumentation for cervical spine injuries from Jun 2011 to July 2013. All 36 patients underwent various instrumentation techniques for stabilization and decompression of the cervical spinal cord. The outcome was compared by the ASIA impairment scale. There were 27 (75%) males and 9 (25%) females. The mean age at presentation was 46 years (17–74 years). The most common mode of injury was fall (62%), with ASIA grade C and D, 31% each. C5/6 level was the most common level (26.2%) of injury. The timing of surgery ranged between 8–270 days from injury. Out of thirty-six, thirty-two patients were available for follow-up. Eighteen of these patients had spinal cord injury and improved by at least one ASIA grade. It is concluded that instrumentation in cervical spine injury is an effective surgical procedure with minimal post-operative morbidity for the management of cervical injury, allowing an improved physiologic environment for maximal neurologic improvement. The post-operative outcome measured on ASIA impairment scale was comparable to international study.

Keywords: Cervical spine, interspinous wiring, American Spinal Injury Association (ASIA)

INTRODUCTION

Overall incidence of traumatic cervical spine injury is 3.7%.¹ Falls are the most common cause of cervical spine and spinal cord injuries in the elderly, with more than 70% of injuries in this age group resulting from this mechanism.²³ Although cervical spine fractures account for 20% to 30% of all spine fractures, only 10% to 20% of cervical fractures result in spinal cord injuries.⁴ Cervical spinal cord injury (SCI) affects 2–3% of all trauma patients and accounts for 8.2% of all trauma related deaths.^{5,6}

One of the methods used for clinical assessment of spinal cord injury is the American Spinal Injury Association (ASIA) impairment scale.^{7,8} It is well known that the recovery from the spinal cord injury depends on the initial severity of the injury or the ASIA impairment scale. The American Spinal Injury Association (ASIA) first published an international classification of spinal cord injury in 1982, called the International Standards for Neurological and Functional Classification of Spinal Cord Injury. Now in its sixth edition, the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) is still widely used to document

sensory and motor impairments following SCI.

The original description of spinous process wiring was published by Hadra in 1891. Mixter and Osgood described the first surgical treatment of atlantoaxial instability in the literature, in 1910.⁹ Methods of posterior stabilization have progressed from interspinous wiring, through facet wiring and sublaminar wiring, to the lateral mass and pedicle screws with plates and rods that are in use today. In 1942 Rogers described the interspinous wiring method used for trauma-induced cervical instability. The first plate for anterior stabilization was designed by Orozco and Llovet in 1970 and was later refined by Caspar.¹⁰ Wiring remained the method used until Roy-Camille introduced the lateral mass screw-plate construct in the 1980s.

The choice of anterior, posterior, or combined anteroposterior instrumentation is based on the clinical scenario and surgeon's experience. Generally, the anterior and middle columns must be capable of weight bearing for posterior instrumentation to be used alone; a combined anterior-posterior approach may be needed if such is not the case.

The objective of the study was to evaluate the outcome of instrumentation in cervical spine injury measured on ASIA impairment scale. To be specific the study aimed to explore the age and sex distribution, determine outcome of different approach to surgical management using different types of instruments as per mode of injury, type of injury and location of cervical injury. We have analyzed a single surgeon series of patients with cervical spine injuries. They underwent cervical spine surgery and instrumentation at Department of Neurosurgery, Bir Hospital, National Academy of Medical Sciences (NAMS).

MATERIALS AND METHODS

After obtaining institutional review board (IRB) approval, prospective observational descriptive analysis of clinical outcomes of 36 patients, who underwent instrumentation for cervical spine injuries were undertaken, from Jun 2011 to July 2013.

At presentation patients were reviewed for the American Spinal Injury Association (ASIA) impairment scale and neurological level of injury along with the radiological evidence of the level. The ASIA impairment scale is 5 point ordinal scale, based on the Frankel scale, using the following categories:^{9,10}

- A = Complete: No sensory or motor function is preserved in sacral segments S4-S5
- B = Incomplete: Sensory, but not motor, function is preserved below the neurologic level and extends through sacral segments S4-S5
- C = Incomplete: Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade of less than 3
- D = Incomplete: Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have a muscle grade that is greater than or equal to 3

E = Normal: Sensory and motor functions are normal

The patients were assessed and evaluated for the clinical neurological level of injury and the level of injury as per radiological findings. At follow up the ASIA grade was re-assessed and radiological fusion and alignment were studied.

Subjects for study included trauma victims, more than 16 years of age, with cervical spine injury of all group and gender irrespective of injury severity who were admitted in the department of neurosurgery, at Bir Hospital. We excluded polytrauma patients admitted under other departments.

All 36 patients underwent various techniques of instrumentation surgeries. Informed consent was obtained from all the participants or their relatives. All the patients were followed up for at least six months. Data had been collected and recorded using a designed questionnaire.

RESULTS

There were 27 (75%) males and 9 (25%) females. The mean age at presentation was 46.17 years (Range: 17- 74 years), with most common age between 31 – 50 years (Figure 1).

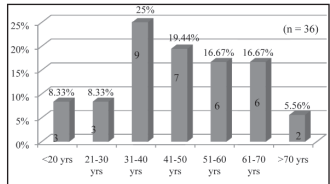


Fig. 1 Age distribution in the study group (n = 36)

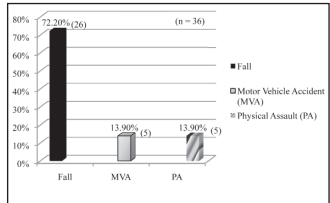


Fig. 2 Mode of Cervical Injury in the study (n = 36).

The most common mode of injury was fall (Figure 2). Sixteen (44.4%) patients had ASIA grade E (Figure 3).

Table 1: Pre-operative ASIA Grading of patients at presentation (n)

ASIA grade	A	B	C	D	E
No. (n = 36)	Nil	4 (11.1%)	5 (13.9%)	11 (30.6%)	16 (44.4%)

Table 2 Neurological level (n = 20) at presentation

	C4	C5	C6	C7	C8
Motor level (n=20)	-	10	8	2	-
Sensory level (n = 9)	2	2	2	-	3

Among 36 patients, 20 patients (55.56%) had spinal cord injury; of which majority was ASIA grade D (Table 1). Most common neurological level was C5 (Table 2).

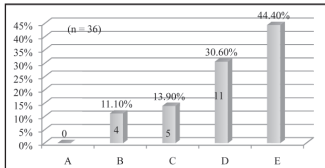


Fig. 3 ASIA grade at presentation

There were 2 patients with Hangman fracture, 3 other patients one each with C2 fracture, C1 burst fracture and C5 fracture. Among the other 31 patients C5/6 level was the most common radiological level of injury which was seen in 14 (38.9%). Twenty-six patients had facet dislocations for which preoperative skeletal traction with Gardner-Wells tongs was attempted. This reduced the dislocation in 19 (52.8%) out of 26 patients (Figure 4).

Being National Neurosurgical Referral Centre (NNRC), we get patients from all over the country. There was a wide interval of time from accident to surgery, from less than a week to 2 and half year (Range 2 – 970 days), with the mean of 56 days and median of 28 days. Most of the patients who were operated after long interval of the trauma were because of their late presentation to the hospital, after sustaining the injury.

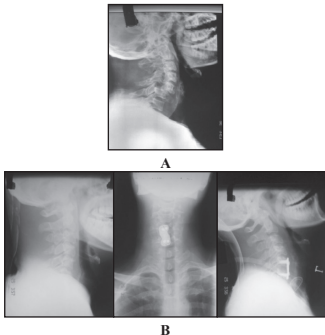


Fig. 4 X-ray Cervical spine lateral views patient showing anterolisthesis C5 over C6. (A) At presentation; (B) After reduction and instrumentation.

Table 3 Surgical Procedure

Surgical Procedure	No. of patients
Anterior instrumentation (19)	
ACDF with Caspar Plate	19
Posterior instrumentation (17)	
Posterior interspinous wiring	9
Pedicle screw fixation	4
Occipitocervical fixation	2
Lateral Mass Fixation	2

Anterior instrumentation with Caspar Plating was done in nineteen patients and remaining seventeen had posterior instrumentation (Table 3). Single level surgery alone was done in 33 patients, while other 3 patients had 2 level surgeries. (Figure 4, Figure 5, Figure 6)

Out of 36 patients 32 (88.89%) patients were available for follow-up from 7 months to 2 years (mean 11 months). 4 patients were lost to follow-up, among them 2 patients did not have spinal cord injury, one had ASIA B and one expired post-operatively. The expired patient had anterior cervical discectomy and fusion (ACDF) C5-6 with Caspar plate & iliac bone autograft, for C5-6 vertebral body fracture with cord compression. Post-operatively he had surgical site hematoma, which was evacuated promptly and was ventilated. Later he developed chest infection.



Fig. 5 Occipitocervical Fixation for C1-2 Fracture

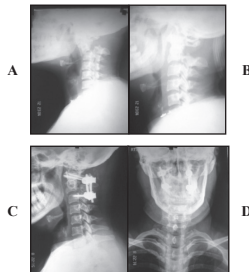


Fig. 6 C1-2 Pedicle screw fixation for Odontoid Fracture A. Pre-traction, B. Post Traction; Post instrumentation (C1-2 Pedicle screw fixation) C. Lateral View, D. AP view

In all the 32 patients followed up, there was good bone formation without any non-union, mal-union or formation of pseudoarthrosis. Four patients had pain at donor graft site (iliac crest) at follow-up, one of them, required support to walk due to the pain.

Table 4 Pre-operative Vs Post-operative ASIA grade (n=32)

Post-op ASIA grade	Post-op ASIA grade			
	B	C	D	E
B	3 (9.4%)	1 (3.1%)	2 (6.3%)	0
C	4 (12.5%)	-	3 (9.4%)	1 (3.1%)
D	11 (34.4%)	-	3 (9.4%)	8 (25 %%)
E	14 (43.8%)	-	-	14 (43.8%)
Total	32 (3.1%)	2 (6.3%)	6 (18.8%)	23 (71.9%)

Among the patients on follow-up, there was spinal cord injury in 18 patients and they had improved by least one ASIA grade by sixth month post operatively. None of the patients had neurological worsening at follow-up. Majority of the patients had gradual improvement over time of surgery (Table 4). Kendal's tau c is calculated to study the relation between pre and post grades. (Kendal's tau C value= 0.65, $p < 0.001$ indicating the relation between pre op and post op is fairly strong and significant)

DISCUSSION

Spinal cord injury (SCI) was labeled as "an ailment not to be treated" in the Edwin Smith papyrus 5000 years ago.¹² SCI has been studied in detail in the Developed world, and thousands of manuscripts have been published in the last few decades. However, not much has changed in many parts of the underdeveloped countries.

Spinal injury is more common than spinal cord injury, reflected in Swischuk's original article on the subject, wherein six of the seven patients presented with spine injury in the absence of a spinal cord injury.¹³ It is estimated that the annual incidence of SCI, not including those who die at the scene of the accident, is approximately 40 cases per million population in the U.S. or approximately 12,000 new cases each year.¹⁴

In Omar et al study, done in Department of Trauma and Orthopaedic Surgery, King Fahd Hospital, Jeddah, Saudi Arabia, the patients ages were from 18 to 82 years (average 38 years).¹⁵ There were 43 (82%) males and nine (18%) were females. The site of injury was between the C4-C7 vertebrae in 82% patients and C3-4 in four

(8%). The demography was comparable to our study.

In our study we had 72.2% of cervical spine injury due to fall. It is comparable to the recent study by Fassett et al., which reported fall as the cause for more than 70% of cervical spine injury.²

Nonsurgical treatment has been plagued by a high incidence of recurrent instability and long-term pain.^{16,17} Surgical fixation has therefore become increasingly favored for unilateral facet injuries, particularly those that are displaced. In the past several decades methods have been developed to stabilize the sub-axial cervical spine both posteriorly and anteriorly, ranging from plates / screws for anterior fixation to polyaxial screw/ rod for lateral mass.

Cervical spine surgery typically represents a field of shared competence between orthopedic surgeons and neurosurgeons. The instrumentation confers immediate segmental stability along the vertebral column and ensures patient compliance by locating the orthosis internally. Its use has been associated with improved fusion and postoperative comfort; those who receive the implants tend to return to work more rapidly than patients who do not.¹⁸

In the case of a failure in reducing the dislocation, surgery with a posterior approach is performed to reduce the dislocation and provide internal fixation. In patients with considerably affected anterior column stability and those with any anterior compression that must be eliminated, such as intervertebral disc herniation or a vertebral body fragment, anterior decompression and fixation surgery is indicated.¹⁹

In a study by Kwon et al, in 2007, a prospective randomized controlled trial of anterior stabilization was compared with posterior stabilization, in which they have not found significant outcome difference in between the two approaches.¹⁶ The advantages of anterior approach are lesser incidence of wound infection and possible better sagittal alignment. The advantages of the posterior approach are more confidence of reducing the dislocation, and no laryngeal/esophageal symptoms post operatively. Both anterior and posterior fixations have been shown to be valid treatment options in a randomized trial for unilateral facet dislocations.²⁰

Ralph et al in 1999, evaluating and assessing 842 patients for 1 year, has documented improvement to ASIAD or E as; 2-3% from ASIAA, 35% from ASIAB, 70% from ASIAC and for ASIAD 95% remained in D while 5% moved to E. A recent publication by Wilson et al, showed ≥ 1 improvement of ASIA score in 25.2% of cases, while 16.4% ≥ 2 grade improvement during follow up.

In present study 44.44% had ≥ 1 grade improvement and 8.33% had ≥ 2 grade improvement in ASIA score. Thus, in our study, the outcome in ASIA impairment scale is comparable with other standard studies for the stabilization of traumatic cervical spine surgeries.

There have been many reports of various complications in cervical spine surgeries, some anecdotal and some reporting on a small series of cases. Recently, Fineberg et al, compared complication and mortality rates for patients treated at teaching hospitals, which have residency training programs, versus non-teaching hospitals.

Using a national database (the Nationwide Inpatient Sample), the researchers identified more than 212,000 cervical spine surgeries performed at U.S. hospitals between 2002 and 2009. The study focused on cervical fusion procedures, performed to join together one or more vertebrae in the upper spine; and various decompression procedures, done to relieve pressure on spinal nerves. In this study they found that the mortality rate was twice as high: 1.2 per 1,000 patients at teaching hospitals, compared to 0.6 per 1,000 at non-teaching hospitals (i.e. 0.06% – 0.12%). The complication rate was also somewhat higher at teaching hospitals: 24.7 versus 17.4 per 1,000 patients i. e. 1.74% - 2.47%.

In our study there was no major neurological complication as such except for 4 patients (11.11%) complaining of pain at the donor graft (iliac) site. We had a mortality (2.78%) due to post-operative surgical site hematoma, which was not recognized in time. Otherwise, all the patients on follow up had good fusion without pseudoarthrosis.

In conclusion, as per our study, there was male preponderance in cervical spine injury that was managed with instrumentation. Majority of the victims were of productive age group. Fall was the major cause of spinal injury. ASIA impairment scale at admission was the single most important factor determining long term neurological recovery. The total clinical outcome had been encouraging as the instrumentation surgery at our centre was recently initiated and the reported series was the initial most series of patients who underwent instrumentation of the cervical spine injury.

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