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Original Research Article

Evaluation of Neurological Outcome in Cervical Spinal Cord Injury and its Correlation with Initial Magnetic Resonance Imaging

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Abstract

Background: Spinal cord trauma is one of the most devastating injuries which leads to disability. Trauma to the cervical cord is even more debilitating in terms of increased morbidity and mortality. In the era of improved medical care and sophisticated diagnostic tests prompt attention to these patients is very vital. Apart from the initial resuscitation and neurological evaluation it is important to perform diagnostic tests so as to assess the extent of concealed injury to the cervical spine.

Methods: Patients who sustained cervical cord injury were assessed for neurology and underwent MRI scan. Neurology was assessed based on ASIA score and cord changes on MRI were evaluated. Some patients underwent conservative treatment, and few others underwent surgical treatment. They were followed up over a period of one year in terms of their neurological status.

Results: Neurological recovery of patients with less severe initial injury was better compared to the patients who had poor initial neurological score and longer extent of cord injury. The patients with higher extent of cord injury on MRI had higher mortality rate and few of them succumbed to cervical cord injury related complications.

Conclusion: The primary injury to cervical cord plays a major role in deciding the final outcome in terms of neurological recovery. Patients with lesser segments cord injury and good neurological score had a better final neurological outcome. MRI plays an important role in evaluating patient with cervical cord injury. It helps to identify patients at risk of developing respiratory complications, to predict the extent of neural recovery at the end of one year and thereby plan appropriate treatment and rehabilitation. Surgical treatment does not play a major role in the management of patients with cervical cord injury.

Keywords: Cervical spine, cord, oedema, ASIA score, MRI.

Introduction

Spinal cord injuries are one of the most debilitating injuries with significant morbidity and mortality. The commonest site of acute spinal injury is the cervical spine [1] with significant neurological deficits. Cervical spine injuries comprise 3-4% of all trauma patients [2]. Early surgical decompression, stabilisation and rehabilitation remain the mainstay of treatment. However the severity of initial traumatic event is the primary determinant of neurological recovery in these patients. Magnetic Resonance Imaging (MRI) is one of the most important radiological studies to evaluate injury to the disco-ligamentous complex and also to assess the injury to the spinal cord. [3-7] The extent of spinal cord injury on MRI could be oedema of the cord or complete transection on the other end of spectrum. This study is undertaken to evaluate whether the extent of cord injury on MRI has any correlation with neurological recovery at one year follow up. [8-10]

Objectives

To assess the extent of cervical cord injury on MRI, Clinical evaluation of neurological injury initially and at the end of one year, to correlate the extent of neurological recovery with the initial MRI findings.

Review of Literature

The etiology of cervical cord injury differs in various age groups, with motor vehicle accidents and sports-related injuries more common in younger individuals and falls in the older population [11]. There is an increase in the number of incomplete lesions [11,12] possibly because of improved treatment at the site of injury and subsequent immediate care [13]. Approximately half of all traumatic SCI are cervical lesions and one third thoracic. The most common neurologic level of injury is C5, followed by C4, then C6 [11]. Burney et al. [13] in their study reported a significant difference in the improvements between complete and incomplete injuries. Neurological recovery was 66% in incomplete and 14% in complete injuries. Rao et al. [14] reported 57.6% recovery in incomplete, and no improvement in complete cord injuries. After injury to the cervical spine immobilization is of vital importance [15-17]. During transportation if this is ignored, the highly unstable injured spine can cause further damage to the spinal cord and also affect the respiratory function [18]. The investigation which has had a great impact on understanding SCI (spinal cord injury) is Magnetic resonance imaging [19]. Out of the several MRI injury classification schemes proposed, Mahmood et al. [19] broadened the six patterns described by Ramon et al. [20] and correlated these findings with the neurological outcome. Acute spinal cord trauma is located at the cervical level in 45-75% of cases [21,22]. The first MRI imaging should be performed 24-72 hours after the injury49 because delay leads to formation of oedema. Early MRI findings for patients with spinal cord injuries, such as the extent of lesion and presence of hemorrhage may be very useful for predicting the neurologic prognosis [10]. Neurologic recovery below the injured level may be more predictable than recovery around the injured level. The recovery around the injured level not only depends on the changes in spinal cord itself, but also on changes in the surrounding anatomical structures, such as nerve root. Shin et al. Slucky AV et al. [25] showed that excellent visualization of neurological and soft tissue structures can be obtained with the help of MRI in cases of acute spinal injury in a non-invasive format. Their study also showed predictive value to spinal cord injury pattern on MRI indicative of long-term neurological outcome. A strong correlation was observed by Andreoli C between MRI appearance of traumatic spinal cord injuries in acute phase and long-term recovery of

motor and sensory functions [26]. In unconscious patients who cannot undergo motor and sensory neurological evaluation MRI is a very useful investigation. Bondurant et al. [27] recommended that the first MRI should be done 24–72 hours post trauma. Leypold et al. [28] told that the length of oedema on T2- weighted sagittal MRI is proportional to the time of imaging after the trauma. Within the first 5 days post spinal cord injury, each 1.2-day delay to MRI imaging increased the length of oedema by one vertebral level. Goulet et al. [29] in their study failed to define the best time for both first and second prognostic MRIs, as well as defining the progression of oedema. It has been shown that while single-level oedema will resolve by 3 weeks, the signal from multi-level oedema will persist beyond this time. Silberstein et al. [30] classified MR appearances of cervical cord into contusion and oedema. Kulkarni et al. [31] classified them into three groups which were broadened by Ramon et al. [32] into six groups. In our study we followed the classification given by Silberstein et al. [30]. The term contusion in our series is similar to that of hemorrhage pattern described by other authors. Kulkarni et al. [31] and Ramon et al. [32] used terms hemorrhage/ hematoma for these lesions. Oedema was the most common imageological finding with incidence of 76%. Kulkarni et al. noted similar results in their studies. Parashari et al. [33] in their study found that hemorrhage (>1 cm) within the cord was the most important prognostic factor. Patients with large cord oedema had initial high grade AIS and less chance of recovery and vice versa. [34] They concluded in their study that various MRI findings in acute spinal cord injury correlate well with the initial clinical findings and on follow-up according to ASIA impairment scale. Hence, MRI is useful for initial diagnosis of acute spinal cord injury. Shin et al. [24] also observed that the motor ratio and sensory ratio improved significantly in patients with cord oedema than in mixed type. Patients with one ortwo segments involvement showed more improvement in motor ratio and sensory ratio than in those with more than two segments involved.

Material and methods

Patients with acute cervical spine injury having neurological deficits admitted to Nalanda medical college and Hospital Patna, Bihar. Study duration of thirty months. These patients were evaluated and assessed at the time of discharge, 1 month, 3 months, 6 months and 1 year follow up.

Inclusion Criteria

Patients with Acute cervical cord injury presenting within 72 hours, Age between 18-60 years.

Exclusion Criteria

Patients with associated thoraco-lumbar and head injury, Patients with autonomic disturbances (bradycardia < 40 beats/min and meanarterial pressure < 90 mm of Hg), Patients who died in course of recovery (during the 6 months period beforefollow up).

In casualty patients with cervical cord injury were treated as per ATLS (Acute trauma and life support) protocol. Later the patients were given ICU care where the vitals and other parameters were closely monitored. Inotropic agents were given to maintain the blood pressure. Type of vertebral column injury and classified according to mechanistic classification based on plain radiograph or CT scan (Allen et al.),Type of spinal cord injury (Complete /incomplete) and neurological injury according to the ASIA grading (admission/1month /3months / 6months /12 months) was done, Initial MRI was assessed and cord lesions were classiified as cord oedema, hemorrhage and hematomyelia. On the MRI scan the extent of cord oedema was calculated based on vertebral extent (as given by Siberstein et al.). The patients were followed up at 1 month, 3 months, 6 months and 1 year interval and assessed for neurological recovery. In surgically treated cases plain radiographs were also taken.

Results

Thirty-one patients matched the inclusion criteria for the study, however, 9 were lost to follow up as they died because of the cord injury. Of the 31 patients included in the study group, 25 (81%) were males and 6 females. The most common mode of injury was fall from height (74%), five patients (16%) had road traffic accident and 3 patients (10%) had other modes of injury such as bull attack and direct trauma. The most common level of injury was C5-C6 accounting to 13 patients followed by C6-C7 where we had 8 patients and C4-C5 with 7 patients. There were few cases with C7-T1 and C3-C4 level of vertebral injury. The extent of cord oedema was divided into segments. There were 16 patients with 5-10 segments involvement. Six patients each with 10-15 and more than 15 segments involvement. Twelve patients with less than 5 segments involvement. A comparison was made between ASIA score and the cord segment involvement at 1 month, 3 months, 6 months and 1 year follow up. The patients with initial ASIA A did not improve their score at 1 month follow up. There were about 3 patients with more than 15 segments involvement and one patient with less than 5 segments involvement and this patient had injury at a higher cervical level (C3-C4). Patients with ASIA B, ASIA C, ASIA D at initial presentation also did not improve at 1 month follow up. After 1 year of cord injury, 3 patients having <5 segments involvement and ASIA D score improved to ASIA E. One patient with ASIA B with 7 segments involved improved to ASIA C. Two patients with 5-10 segments involvement improved to ASIA E. Two patients with 5-10 segments involvement and ASIA B improved to ASIA C. One patient with 10-15 segments involvement and ASIA A improved to ASIA B. This shows that if a patient has initial low ASIA score and extensive cord involvement the scope of recovery after 1 year is guarded and is poor. Out of the nine patients who died 8 of them had diaphragmatic type of breathing and one patient had normal type of breathing pattern. Most of them died within 3 months of trauma.

Table 1: Surgical intervention

Parameter	Number of patients
Surgical intervention	11
Neurological improvement (after 1 year)	2

A total of 11 patients underwent surgical intervention on elective basis. Only 2 patients had neurological improvement by grade 1 at the end of 1 year. One of the patients died within 3 months after trauma.

Table 2: Conservative treatment

Parameter	Number of patients
Conservative treatment	20
Neurological improvement (after 1 year)	9
Death	8

We had 20 patients who underwent conservative treatment out of which 8 patients died. Nine patients had improvement in the neurological outcome by one grade at the end of 1 year. Three patients did not have any improvement in the ASIA score.

Figure 1: T1 weighted sagittal MRI image showing cord oedema extending fromupper end plate of C6 to upper end plate of C7

Discussion

Injury of the cervical cord can be either direct or indirect. Indirect mostly leads to whiplash injury. Direct injury in the form of direct trauma, road traffic accident and fall from height are quite common. In this study we found that most common mode of injury was fall from height. The height of fall was directly related to the severity of injury. This was reflected as low neurological score at presentation and more segment involvement on MRI scan. The cumulative effect of these two factors is reflected as poor neurological outcome at one year follow up. The most frequent vertebral level of injury was C5-C6 in this study which is in concurrence with literature. MRI plays a vital role in patients with cervical cord injury. The extent of cord injury and other soft tissue changes can be well visualized using this investigation. Along with plain radiograph MRI helps to classify the cervical spine injury and also to decide the line of management for these patients. MRI should be done as soon as possible

preferable within 72 hours from injury. In our study all the patients underwent MRI scan within 72 hours from the time of trauma. Most of the patients with cervical cord injury end up with respiratory distress due to involvement of the respiratory muscles. Following trauma cord changes such as oedema and or haemorrhage develop. The higher extent of these cord changes on MRI can help explain the involvement of Phrenic nerve and hence the respiratory insufficiency. After cervical cord injury the diaphragm is the main respiratory muscle as the intercostal muscles are paralyzed. In our study patients who had respiratory insufficiency had higher cervical extension of cord oedema. The morbidity and mortality in such patients was higher. We had nine patients in our study who died as result of respiratory and autonomic dysfunction. Silberstein *et al.* classified MR appearances of cervical cord into contusion and oedema [6]. Kulkarni *et al.* classified them into three groups[7]. Accordingto Selden *et al.* cord oedema on MRI is associated with good recovery of neurological function, more so when it involves a small portion of the spinal cord [9]. Rao *et al.* noticed maximum recovery of patients with cord oedema less than three segments, compared

with other patterns of injury. In our study we followed the classification given by Silberstein *et al.* [6]. The cord oedema was studied on the MRI scans and was divide into various segments. This helped to follow up and correlate the patients to their respective ASIA scores. More extensive the cord oedema were the chances of recovery. Most of the patients showed improvement in their ASIA scores. Nine patients were lost to follow up because they died as a consequence of complications related to cord injury within one month of trauma. We had nineteen patients in our study with complete cord involvement out of which nine died. The remaining ten patients were followed up to a period of one year. There were twelve patients with incomplete cord involvement. There were three patients with complete cord involvement who improved by one ASIA score at the end of follow up. The initial injury in these patients was massive and there was extensive of cord oedema. A total of eight patients with incomplete cord involvement showed improvement in their ASIA score at the end of one year. These patients had less severe initial injury and lesser segments involvement on the MRI.

Conclusion

Cervical cord injury is a very debilitating injury having a high mortality rate. These patients have to be evaluated clinically and radiologically. MRI scan is very vital in these patients. It helps know the extent of injury, further plan of treatment and predict the final neurological outcome in patients with cervical cord injury. The patients with initial complete injury have a higher mortality rate and hence surgical intervention in them may not be of much benefit. Whereas patients with better neurological status and lesser extent of cord injury may be treated conservatively or surgically based on the severity score.

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