

## Brief Report

# The Neurological Outcome of Spinal Cord Injured Victims of the Bam Earthquake, Kerman, Iran

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### Abstract:

Car accidents and gun-shot injuries are the most common causes of spinal cord injury. Five percent of those patients who have a complete spinal cord injury will experience improvement, to some extent. The lack of specific data in the literature regarding the outcome of earthquake related spinal cord injury justified us to design this study where we evaluated the neurological outcome and related factors of SCI in the Bam earthquake.

We retrospectively evaluated the neurological outcome of patients with spinal cord injury who survived the Bam earthquake. In this study all patients with spinal cord injury that resulted from the Bam earthquake who registered in the Welfare Organization of Kerman were studied. The neurological conditions of patients eighteen months after the earthquake were compared with their neurological conditions at the time of the earthquake.

A total of 17 (23.9%) patients with grade A impairment based on ASIA impairment Scale (AIS) at the time of the earthquake had significant neurological recovery. In addition, younger patients had better neurological outcomes. Those who had fracture dislocations had a worse outcome.

Spinal cord injuries that are due to earthquakes have a better neurological outcome in comparison with other causes of this injury. The patients' ages and types of spinal fractures were significantly related to the neurological outcome.

**Keywords:** Bam earthquake, neurological outcome, spinal cord injury

## Introduction

An earthquake measuring 6.3 on the Richter scale struck the city of Bam in Kerman Province, Southeastern Iran on the 26<sup>th</sup> of December, 2003 at 5:26 a.m. It was a disaster; the city was destroyed with over 40,000 people dead and nearly 30,000 injured. Of those injured, approximately 130 had

spinal cord injuries (SCI) that were related to the earthquake.

As is known, the most common causes of spinal cord injury (SCI) are car accidents and gun-shot injuries.<sup>1</sup> Two out of three patients with SCI are below the age of 39 and more than 80% are male.<sup>2</sup> In patients with complete SCI, 5 to 10% will experience an improvement to some extent.<sup>1</sup> Previous studies have shown that factors such as age, gender,<sup>3</sup> etiology, severity, and level of injury<sup>4</sup> can affect neurological improvement. On the other hand, the velocity of trauma is a prognostic factor. For example, in a high velocity trauma the spinal cord sustains a more severe injury.<sup>4</sup> Therefore, the trauma's velocity is a potential contributor to motor recovery, patient function and outcome following an SCI.<sup>5</sup>

When considering the type of trauma, it seems that the demographic characteristics of earthquake affected patients, particularly their ages and gender

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are different from those of SCI patients who suffer from other types of trauma. It is possible that the neurological outcome in these patients differs as well. Thus, a retrospective, cross-sectional study was performed to evaluate the demographic data and neurological outcome of patients with earthquake related SCI. Additionally, we tried to determine a relationship between neurological improvement and various factors such as age, gender, level, and severity of neurological injury in this population.

### Patients and Methods

The study was conducted from April 1, 2005 to March 31, 2006. This research was reviewed and approved by the Institutional Review Board of Kerman Medical Rehabilitation Research and Education Corporation. Additionally, the study protocol was approved by the Ethics Committee of Research Affairs at Kerman University of Medical Sciences, Kerman, Iran (agreement no. EC/KNRC/84-5).

Participants consisted of all patients with SCI which resulted from the Bam earthquake who were registered at the Kerman Welfare Organization. All patients were visited in their homes or in the physiotherapy center in the city of Bam. After informed consents were obtained, all participants received a comprehensive physical examination to evaluate their current neurological status. Medical records and patients' imaging studies were carefully reviewed in order to determine their initial neurological status (at the time of primary hospital admission) and associated injuries, levels and types of spinal fractures. SCI completeness was classified by the ASIA Impairment Scale (AIS). The AIS is classified as follows: A) Complete: no sensory or motor function preserved in the fourth or fifth sacral segments; B) Sensory incomplete: sensory but no motor function preserved below the neurological level and extending through the fourth or fifth sacral segments; C) Motor incomplete: motor function preserved below the neurological level and the majority of key muscles are grade <3; D) Motor incomplete: motor function preserved below the neurological level and the majority of key muscles are grade >3; E) Normal: although hyper-reflexia may be present, normal sensory and motor recovery are exhibited. Neurological improvement was defined as the relative change in AIS. Moreover, all patients were asked about their

physical position at the moment of the earthquake.<sup>1</sup>

Complete analysis was carried out using SPSS version 15. To assess factors associated with participants' interest in neurological improvement, an ordinal logistic regression model with strength of desire for neurological improvement as the dependent variable (0=no change, 1=a one or two grade improvement, and 2=three or four grade improvement) was used. Gender, age, type of fracture, level of injury, association with other types of injury and position of patients during the earthquake were also included in the model.

### Results

According to the report published by the Welfare Organization of Kerman, 130 individuals had registered as earthquake related SCI patients before the start of our study. This organization estimated that out of all SCI victims of the Bam earthquake, just less than 10 patients had not been registered. Out of 130 registered patients, 27 patients dropped out of the study due to their address changes. Therefore a total of 103 patients were included in the study.

The population consisted of 42 (40.8%) males and 61 (59.2%) females with a mean age of 31.5 years (SD=10.2). A total of 63% of the patients had not completed a secondary school education and 37% had a higher educational level.

Thirty-two patients were in a sitting position and a heavy load forced them to bend forward whereas 17 (16.3%) were in the supine position. The median time between the earthquake and rescue was one hour (IQR 30 min – 2.62 hours). These patients were admitted to several hospitals throughout the country. The median length of stay in acute care institutions was 30 days (IQR 17 – 45 days) with a maximum of 150 days. There was no significant relationship between duration of hospitalization and neurological outcome.

Demographic data and their relationship with neurological improvement is summarized in Table 1.

Two (1.9%) individuals sustained an injury at the cervical, 8 (7.8%) at the thoracic and 93 (90.3%) at the thoracolumbar levels. SCI was classified at the time of discharge as A: 68.9%, B: 16.5%, C: 10.7% and D: 3.9% using AIS classification.

The fracture type was determined in 76 patients. Of these, 37 (37/76=48.7%), 23 (30.3%) and 10

**Table 1.** Demographic data and their relationship to neurological improvement

	Beta	P-value
Gender		
Male	Ref.	
Female	0.279 (-0.747 – 1.333)	0.626
Age		
<40 yr	Ref.	
>40 yr	0.052 (0.001 – 0.103)	0.046
Position		
Sitting	Ref.	
Other	0.473 (-0.370 – 1.747)	0.404
Fracture type		
Fracture Dislocation	Ref.	
Other types of fractures	-1.292 (-2.342 – -0.242)	0.016

Ref. =reference group; yr=year; Numbers in brackets show 95% confidence intervals.

(13%) had burst fractures, fracture-dislocations and wedge fractures, respectively. Patients with fracture dislocations had worse neurological outcomes compared to the other types of fractures.

In 34 (33%) patients there were associated injuries. The most common accompanying injury was a lower extremity fracture. None of the patients received high dose methylprednisolone after rescue.

Eighteen months after injury, the neurological status of the patients was classified as A: 27 (26.2%), B: 11 (10.7%), C: 27 (26.2%), D: 25 (24.3%) and E: 13 (12.6%). During this period, 17 (23.9%) patients with grade A impairments at the time of the earthquake recovered sufficient hip and knee strength to ambulate with the use of conventional orthoses.

We did not find any significant relationship between neurological improvement and factors such as gender, level of injury, primary neurological condition and accompanying injuries. However, there was a significant relationship between neurological improvement and age. In fact, younger patients (<40 years) had a much better neurological outcome ( $P<0.05$ ). A significant relation between neurological outcome and fracture type (i.e. those with fracture dislocations had worse neurological conditions) was also seen ( $P<0.016$ ). The patients' positions during the earthquake did not affect their neurological conditions at the time of the earthquake ( $P=0.52$ ) or neurological improvement during the first 18 months after the injury ( $P=0.52$ ). Position also had no significant effect on the type of fracture ( $P=0.87$ ).

## Discussion

Approximately 60% of our cases were female as was also reported by Raissi,<sup>6</sup> however, other studies reported differently.<sup>7</sup> These studies showed that the most common cause of SCI was due to car accidents which were more frequently seen in the male gender.<sup>7</sup> In any quake, however, there should generally be an equal chance for SCI in both genders. The reason that the majority were female victims may be related to the local culture, in which men go to work early in the morning. But this is only a conjecture because access to the city's demographic information prior to the earthquake as well as those who died following the quake was impossible.

The oldest patient was 60 and the youngest one was 17 years old. Theoretically, in this type of trauma, there should have been a wider span of patients' ages. We speculate that the very young and very old, being more vulnerable, could not withstand the trauma.

In other studies the cervical level was the most involved area<sup>7</sup> but in our population we had just two patients with cervical spinal injury. In vehicle accidents severe and sudden neck motion causes significant harm, but in a quake the major force is generally applied to the back. However, another explanation for this difference was the lack of adequate medical attention during the crisis phase that increased the mortality of patients with cervical SCI.

Thirty-one percent of the patients were in hyperflexion at the time of the quake but we detected no

relation between the position and the type of fracture.

Thirty-three percent of patients recovered sufficient hip and knee strength to ambulate using conventional orthoses. In other studies the rate of improvement has been reported at 2 – 5%<sup>8</sup> with high-dose methylprednisolone given to the majority of them. Meanwhile, neurological improvement is much better at the cervical level, but in our population only 2% of the patients suffered from cervical cord injuries. With that consideration, we can claim that our group had a better neurological improvement rate which may result from the fact that earthquake trauma is not a high velocity trauma.

In our study we found a significant relationship between neurological improvement and the types of fractures. Patients with fracture dislocation showed less improvement than those with other types of fractures since those who had fracture dislocations were exposed to more severe traumas and displacement of bony elements can mechanically disrupt the spinal cord.

Other studies have reported accompanying injuries as a factor that adversely influences neurological outcome because more accompanying injuries show the severity of trauma that simultaneously harms the spinal cord.<sup>9</sup> In earthquake induced trauma, however, each body part can be traumatized separately under different loads with different forces. Thus each injury is independent from the others which was also true in our study.

## Conclusion

The neurological outcome of patients with SCI due to earthquakes is better than other types of traumas, which may be explained by the differences in trauma velocity.

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