A Rare Study of Electric Shock Associated Spinal Injuries: Prognosis and Outcome

Ravi Gaur[1], Nimish Mittal[2], Mrinal Joshi[3], Krishna Dubey[4]

ABSTRACT

Introduction: Electric shock associated with spinal injury is a rare type of trauma in the world with only few citations available for the same. In India, only a few case reports from various burn units are mentioned. To gain some insights on the magnitude of this problem in Indian context; we carried out this prospective study in our spine injury department to study the epidemiological data associated with spinal trauma secondary to electric shock and to study the neurological recovery patterns in electric injury leading to spinal cord injury.

Material and Methods: A study for demographic data collection along with neurological recovery patterns in such patients was conducted over a period of 21months from 1st October 2008 to 30th June 2010. All the patients having such type of injury were evaluated on ASIA scale and Lund and Browder chart for neurological assessment and assessing associated burn and marking entry and exit sites respectively. Radiological assessment with MRI was done to assess the vertebral injury, spinal cord injury and canal compression.

Results: No neurological improvement was noted in patients with such kind of injury over the period of one year follow-up suggesting the graveness of such type of injury. Associated findings of polyneuropathies were of no such significance, as paraplegia leads to complete loss of motor and sensory loss.

Conclusion: Complex form of trauma along with almost no recoveryis the rule in cases of electric shock associated spinal trauma. Most of the families are devastated as nowadays trend for nuclear families is more pronounced even in rural area. Polyneuropathies found in such cases are not affecting the outcome as spinal injuries are severe and almost showing no recovery. Multiple level vertebral fractures were almost present in half of the cases suggestive of severity of trauma.

Keywords: Spinal injury, Electric shock, Vertebral fractures.

INTRODUCTION

Electric injury associated spinal trauma is a very low incidence injury as only 2% of cases having electric injury are also having electric shock.[1] The investigator of the present study noted that the number of spinal injury associated with electric shock are quite prevalent in the Sawai Man Singh Hospital as compared to western counterparts and available international data does not show the exact picture of Indian context. The chief causes of accidents associated with electricity were clothes catching fire, falls, crushing and being struck by objects.[1] Risk factors included contact with moisture or working on damp ground. Literature on spinal cord damage after electrical trauma is scarce and the incidence, early diagnosis and treatment of this condition remain to be elucidated. In India; electricity is transmitted in AC form at 50 Hz at 220V, 440V, 11KV and 33KV. In industrial complexes 6.6KV is mainly used.[2] However, the long-term sequelae of the electrical injury might be more subtle, pervasive, and less well defined, and are particularly difficult to diagnose, as the link between the injury and the symptoms can often go unrecognized by patients and their physicians.[2] Many who suffer electrical injury have considerable difficulty returning to work.[3] In an article on the delayed syndromes in patients with electrical injuries, it was speculated that exposure to electric fields is similar to the effects of irradiation.[4] So the present study aimed to study were to study the epidemiological data associated with spinal trauma secondary to electric shock admitted to Dept. of P.M. and R. during 1st Oct. 2008 to 30th june 2010 and to study the neurological recovery patterns in electric injury leading to spinal cord injury.

MATERIAL AND METHODS

In this prospective study, 45 patients were recruited, who were admitted to as an inpatient spinal injury rehabilitation program in Department of Physical Medicine and Rehabilitation in Sawai Man Singh Hospital, Jaipur between 1st October, 2008 and 30th June, 2010. All acute spinal cord injury patients associated with electric shock, presented to our department were recruited in this study.

For epidemiological assessment, a clinical interview was carried out from patient and care givers. Diagnosis of spinal injury was based on Neurological assessment on American Spinal Injury Association (ASIA) scale and radiological evidence of vertebral injury or canal compromise on X-ray, CT scan or MRI.[1] To find out electric shock associated injuries, echocardiography (ECG), nerve conduction velocity (NCV) and lab investigations were also carried out as relevant to the injury and management. Electrical burn wounds were assessed on Lund and Browder chart and entry and exit wounds were identified and marked to identify path of current and associated lesion. Patients were periodically assessed every three month's period for neurological recovery patterns and rehabilitation needs up to a maximum duration of one year and minimum duration of six months. Consent was taken from the all the patient who were recruited in this study. The study was approved by the hospital ethical committee. Detailed history based on the memory of the patient was obtained regarding the site coming in contact

[1]Assistant Professor, Department of Physical Medicine and Rehabilitation, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, [2]Senior Resident, AIIMS, New Delhi, [3]Head of Department and Professor, Department of Physical Medicine and Rehabilitation, Sawai Man Singh Medical College, Jaipur, [4]Junior Resident Final Year, Department of Pathology, NIMS Medical College, Jaipur, India

Corresponding author: Dr.Ravi Gaur, H.No.-405, Dr. RMLIMS Faculty Residence, TC 40-41, Near Indian Oil Corporation Office, Vibhuti Khand, Gomti Nagar, Lucknow, UP-226010, India

How to cite this article: Ravi Gaur, Nimish Mittal, Mrinal Joshi, Krishna Dubey. A rare study of electric shock associated spinal injuries: prognosis and outcome. International Journal of Contemporary Medical Research 2016;3(8):2450-2453.

with the source of electricity and any associated burns like joule burns for assessment of site of entry and exit.

STATISTICAL ANALYSIS

SPSS version 16.0 was used for analysis. Mean age of patients were calculated. Percentage of injuries were calculated to to infer the results of the present study and compare with the available literature.

RESULTS

Out of 2358 spinal cord injury patients admissions during the study period; 45 cases (1.91%) were enrolled as cases of spinal injury due to electric shock. All cases enrolled in the study were males. Out of 45, 43 (94%) cases are from rural area. Most of the patients were in between 20 -40 year of age group with a mean age of 32.59 years (table-1). The most common time of injury was between 5:00 A.M. to 5:00 P.M. (working hours) and no cases were reported who received the injury between 11:01 P.M. to 5:00A.M.

Only two patients were below 20 years; were working as line men/ electrician on temporary basis in government electricity board. One case was welder and got shock while checking connection of welding machine.

Most of the victims (73%) were educated up to secondary education, where as 17% were completely illiterate.

Most of the persons associated with this kind of injury were of low socio-economic group as 62% cases have income less than Rs.5000/Month (<100$ / month) with family size of at least five persons. As opposite to the traditional belief, nuclear families (30 out of 43; 69.76%) are becoming more prominent in rural Indian society. In this study, average family size in nuclear families was 5.27 and for joint families was10.93.

In the study group the most common type of injuries were dorsal spine injuries (28 out of 45; 62.22%) followed by cervical injuries (10 out of 45; 22.22%) (figure-1).

Mode of transportation to the hospital immediately after trauma was mainly jeep as ambulance facilities were scarce and costly. Average associated fall from height was 11.75 feet, which is suggestive that predisposing factors were deliberate reach to the electricity source by the affected persons. Hands were the most common sites of entry as they get injured while using tools (42 /45; 93% cases). Right hand involvement was found greater than left hand which might be due to right hand dominance in people. In some cases tongue and upper back were also marked as site of entry of electricity. Most common exit site of electricity were legs (53%) followed by hands (22%) and then rare sites like upper back, abdomen etc. In four cases site of exit could not be established (figure-2).

All the tetraplegic patients showed no signs of recovery with very high mortality (6 out of 12; 50%) at the end of completion of one year of study duration. At the end of study; a total of 34 out of 45 patients(75.55%) were recorded in ASIA 'A', 2 were recorded in ASIA 'B'(4.44%), one case each of ASIA 'C' and 'D' and ASIA 'E' included 7 cases (15.56%). None of patients recruited as ASIA 'A' improved. Only 2 patients out of

S. No.	Age	Cervical	Dorsal	Lumbar	No Bone Injury
1	0-20Yrs.	3	4	1	0
2	21-40 Yrs.	5	21	1	1
3	41-60 Yrs.	2	3	2	2
4	>60 Yrs.	0	0	0	0

Table-1: Age group- type of injury

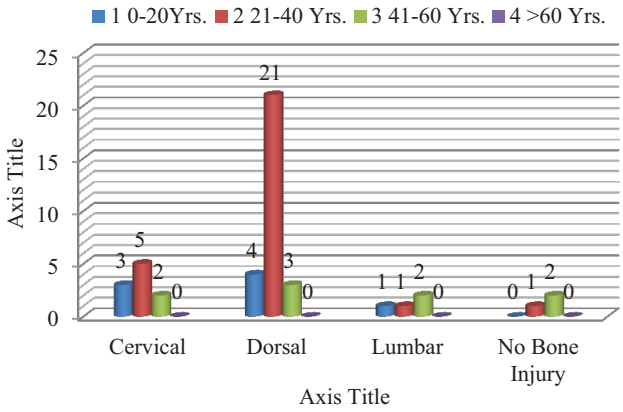

Figure-1 Associated Vertebral Injury

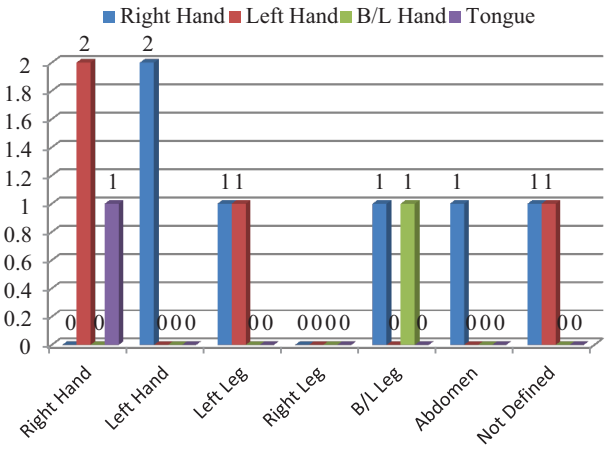

Figure-2: Site of entry/exit in cervica cases

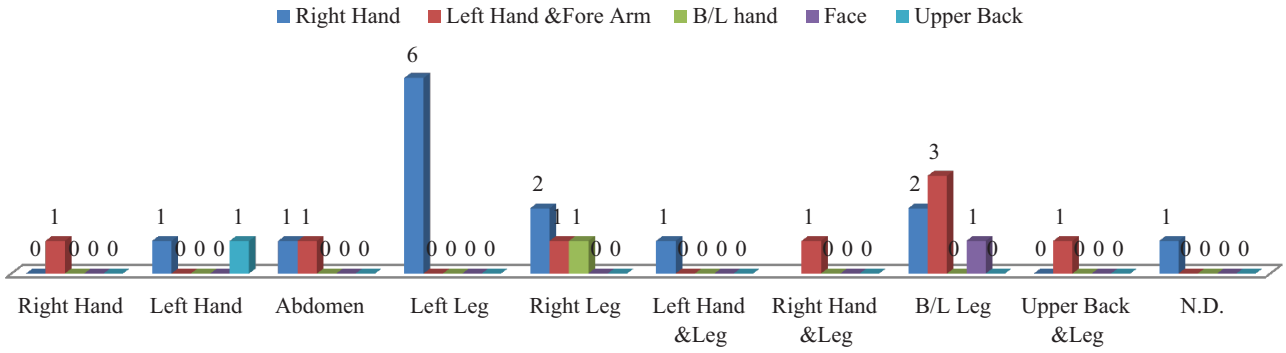

Figure-3: Site of entry/exit in dorso-lumbar cases

45 showed signs of partial recovery. One patient improved from ASIA 'B' to 'C' where as one another patient improved from ASIA 'D' to 'E' (figure-3).

Electricity also affects peripheral nerves suggested by presence of sensory and motor affection on Nerve Conduction Studies.

In all tetraplegic patients the site of entry was hands (11/12) or tongue (1/ 12) with exit sites was in opposite hand (41.67%), legs (33.33%) or not defined (25%).

In paraplegia, 16 cases out of 26 (61.53%) showed sign of entry in hands and site of exit in legs. Similarly 3 cases out of 26 (11.53%) were found with entry site in hand and multiple exit sites in hand and leg. One case showed site of entry on face with exit on bilateral legs. In another case entry site was found on upper back with exit site on left hand. In 2 cases, with entry site was on hands and the exit site was observed on abdomen. In one case entry site was on hand but no defined exit site was found. Two paraplegic patients out of 26 cases (7.7%) showed site of exit in opposite hand.

At the end of one year follow up, mortality was 11 (24.44%) which suggest that it is a grievous type of injury. In these eleven fatal cases, 6 cases were of cervical injury, 4 had dorsal injury and one case hadno bone injury.

DISCUSSION

Daniel P. Lammertse analyzed records of The Rocky Mountain Regional Spinal Injury System database at Craig Hospital and found 9 cases of spinal cord injury caused by electrical trauma out of 9363 SCI admissions over the period 1972–2003, representing slightly less than 0.1% of the cases. In our study this percentage was much higher (1.91%; 45/2358) suggesting different approach should be adapted to such problem in our country.

Koumbourlis AC proposed that there is no specific therapy for electrical injury and the management is symptomatic.[5] We completely agree to the fact as daily dressing of burn wounds, care as for acute spine injury patient along with early rehabilitation interventions while treating patients were the main guidelines followed.

EyadBaqain, Peter Haertsch, Peter Kennedy etal in their tertiary adult referral unit found only one third of cases associated with high voltage lines,[6] whereas in our study spinal injuries associated with high tension lines (11 KV/33 KV) accounted for 66.67% (30 out of 45 cases) while low voltage line related trauma was 33.33%(15 out of 45) cases.

Cherington M. proposed that Peripheral nerve lesions are uncommon in lightning-strike patients. By contrast, peripheral nerve injuries are common with generated electrical trauma.[7] In our study we agree that generated electricity causes affection of peripheral nerves but doesn't have significant impact on outcome as there is almost no neurological recovery after spinal injury in such cases.

Mary Ann Cooper in her study had two third of fatalities between the ages of 15 years and 40 years.[8] In our study too, the average age was 32.59 years and the age group of 21-40 years was the largest among the injured with35 patients (35/45; 77.78%) between 15 years and 40 years of age. Dorsal injuries were the most prevalent in this age group (28out of 45 patients; 62.22%) which lead to a paralytic life followed by cervical (10/45; 22.22%) and lumbar (4/45; 8.89%)injuriesas none of them recovered at the end of one year. In three patients no bone injury or SCIWORA (spinal cord injury without radiological evidence) could be defined as even magnetic resonance imaging was normal.

Most of the injuries occurred between 5:00 A.M. to 5:00 P.M. 38 out of 45 cases (≈85%) (working hours). Rest 7 cases were recorded in evening hours between 5:00 PM. To 11:00 P.M. No injury was recorded between 11:00 P.M. to 5:00 A.M.

R.C. Lee[9] described the biophysical injury mechanism in Electric shock trauma.[9] Upper limbs as well as upper chest and back were the most commonly affected area by burns. Major Burns were mostly arc or flash burns or when the clothes made of synthetic polyester or nylon fabric catches fire. Almost all cases (40/45; 88.89%) had at least joule burn or flash burn due to contact with electricity. Presence of contact points is diagnostic of an electrical injury beneath the skin. The skin appearance at the site of contact is often that of a well-defined charred wound that is depressed due to loss of tissue bulk.

Superficial electric burns have similar prognosis as burns from other causes but deep burns have delayed healing as compared to other causes of burns; because of the specific effect on nonviable tissue covered by healthy uninjured skin.

Sang HoonKo et al studied the relation between site of entry and exit to the level of injury. They found that, if site of entry is in head and neck area and exit site in lower limbs than the chances of paraplegia are more common. If both upper limbs and lower limbs are involved than chances of quadriplegia are more common.[10] In our study, the data reflects this is not always true. Hands were the most common sites of entry as they get injured while using tools or touching wires with bare hands (42 /45; 93% cases). Right hand involvement was found greater than left hand which might be due to common right hand dominance in most of the people. In one of the cases tongue was seen as the mark of entry wound, this happened with a carpenter who was trying to peel off electric wire with his teeth; he presented as a tetraplegic with no exit wound and he passed away due to sudden cardiac dysrhythmias. Most common exit site of electricity was legs (53%) followed by hands (22%) and then rare sites like upper back, abdomen etc. In four cases exit wound site was not seen or appreciable.

Brian James Daley et al also suggested that electric burn patients may present with bone fractures from either severe muscle contractions (eg, avulsion fractures) or as a result of falls. This was more commonly seen in upper limb long bones and in vertebrae.[11] In our study, multiple vertebral fractures were a common phenomenon (21/45; 46.67%). the largest group was dorsal spine injury (28/45; 62.22%) followed by cervical region (10/45; 22.22%) and lumbar spine injury (4/45; 8.89%). Three patients (3/45; 6.67%) had no bone injury. Out of these 28 cases of dorsal spine injury, 24 patients (24/28; 85.71%) had at least one fracture in D-4 to D-8 region. Two patients reported fracture of clavicle while one patient had fracture of mandible as associated injuries. Multiple rib fractures were also recorded. One paraplegic patient also had loosening of teeth.

Patients after spinal trauma secondary to electric shock had a poor prognosis. Most common causes of death in dorsal spine injury were pressure sores leading to cachexia which is associated with protein and blood loss and septicemia due to infections of these wounds. One patient with no bone injury had

very large flash burn (90%) and expired on third day due fluid loses from open burn wounds.

CONCLUSION

Dealing with electricity at electric poles is most of the time associated with fall from height. Combined effect of injury by electricity along with fall from height leads to more complex form of trauma like multiple vertebral fractures with preference to dorsal region and almost no neurological recovery. This can be prevented most of the timeswhile embarking on the electrical poles afterwearing proper fall and electric shock preventive suits along with proper communication while dealing with high tension lines maintenance. Semi-skilledlaborers without proper education are the main cause of such calamities.Early rehabilitation will definitely help the patient to overcome such catastrophe by proper health care and along with preparing the person and his family psychologically, physically and vocationally for maintaining the person in the main stream of society. As compared to the western data; in Indian scenario electric injury associated with spinal trauma is quite large in number and due to poor financial support giving proper rehabilitation becomes difficult.

REFERENCES

1. Daniel P. Lammertse; Neurorehabilitation of spinal cord injuries following lightening and electrical trauma; Neurorehabilitation. 2005;20:9-14.
2. Bailey B, Gadreault P, Thivierge RL. Neurologic and neuropsychological symptoms during the first year after an electric shock: results of a prospective multicenter study. Am J Emerg Med. 2008;26:413-8.
3. Pliskin NH, Capelli-Schellpfeffer M, Law RT, Malina AC, Kelly KM, Lee RC. Neuropsychological symptom presentation after electrical injury. J Trauma. 1998;44:709-15.
4. Farrell DF, Starr A: Delayed neurological sequelae of electrical injuries. Neurology. 1968;18:601-606.
5. Anastassios C. Koumbourlis; Electrical injuries; Crit Care Med. 2002;30[Suppl.]:S424 –S430.
6. EyadBaqain, Peter Haertsch, Peter Kennedy; Complete recovery following a high voltage electrical injury associated with delayed onset of quadriplegia and multiple cranial nerves dysfunction: a case report; Burns. 2004;30: 603–605.
7. Cherington M, Yarnell PR, London SF: Neurologic complications of lightning injuries. West j Med. 1995;162:413-417.
8. Mary Ann Cooper; Emergent Care of Lightning and Electrical Injuries; Seminars in Neurology. 1995;15:56-60.
9. Lee, Zhang and Hannig; Biophysical injury mechanisms in electrical shock trauma; Annu. Rev. Biomed. Eng. 2000;02:477-509.
10. Sang HoonKo, Wook Chun, Hyun Chul Kim; Delayed SCI following electrical burns, a7 year experience;Burns. 2004;30:691-5.
11. Brian James Daley, Jose Fernando Aycinena, Ali Farouk Mallat; Electrical Injuries: June, 2008.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 01-07-2016; **Published online**: 12-08-2016