

# Challenges in the Rehabilitation Management of a Patient with Spinal Cord Injury Without Radiographic Abnormality (SCIWORA) Secondary to High-voltage Electrical Burn Injury with Multiple Disabilities: A Case Report

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## ABSTRACT

A 22-year-old male who came in contact with a high-voltage wire, with entry point at the head and exit points at the ankles, presented with flaccid paraplegia and loss of sensation of bilateral lower extremities with no radiographic abnormalities. Several burn-related medical complications arose during the admission, as well as episodes of demotivation. Bilateral below the knee amputation was done because of extensive burn injuries of the lower extremities. The rehabilitation management for a patient with multiple disabilities needed to be tailored depending on the limitations and needs of the patient at a certain point in time. Despite the challenges, satisfactory results were achieved, through telerehabilitation and employing a multidisciplinary team approach.

*Key Words: Multiple disabilities, spinal cord injury, electrical burn injury, amputation, case report*

## INTRODUCTION

A 22-year-old man, part-time kitchen staff, with no known comorbidities sustained an electrical burn injury after accidentally coming in contact with a high-voltage power cable. He lost consciousness, fell from standing height, and woke up confused, with weakness and numbness of the lower extremities. Initial examination in the emergency room revealed burn injuries affecting 15% of the total body surface area (TBSA) with entry wounds on the vertex of the skull and exit wounds on the medial aspect of bilateral ankles. He also sustained burn injuries on the upper back, right shoulder, and right torso (Figure 1). He had intact higher cortical functions and normal cranial nerve examination but was paraplegic with impaired sensation starting from the L1 dermatome. The bulbocavernosus reflex, perianal sensation, and sphincter tone were intact.

Electrocardiography, cardiac markers, spine radiographs and MRI with gadolinium contrast all had normal results. The patient was assessed to have an electrical burn 15% TBSA; spinal cord injury without radiographic abnormality (SCIWORA), American Spinal Injury Association Class B, incomplete (sensory level: T12, motor level: T12, neurologic level: T12) secondary to electrical burn injury.

The goal of rehabilitation management was to achieve independence in activities of daily living (ADL) including

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**Figure 1. (A)** Entry wound on the vertex of the skull. **(B)** Burn extent on the torso and back. **(C)** Exit wounds on the lower extremities.

transfers and wheelchair propulsion. On initial psychological evaluation, the patient was found to be highly motivated as his Spinal Cord Independence Measure (SCIM) score improved from 23/100 at the time of referral to rehabilitation medicine, to 46/100 on the 25<sup>th</sup> post-injury day, indicating improved participation in his ADLs.

The rehabilitation process was not without challenge. During the course of admission, the patient had recurrent bouts of hospital-acquired pneumonia, electrolyte imbalances, deconditioning, and skin and soft tissue infection on the exit wounds requiring repeated debridement. The patient deteriorated and eventually needed complete assistance in his ADLs, with a decline in his SCIM from 46/100 to 39/100. He was poorly motivated and preferred to be assisted all the time. Rehabilitation management was centered on preventing complications of immobility and worsening of deconditioning. The patient was also referred for counseling and it was found that the poor motivation stemmed from frustration over the poor healing of injuries despite repeated surgeries.

As the other medical problems were eventually well-managed, with concomitant improvement in his psychological disposition, the patient's skin and soft tissue infection, however, worsened. With the exposed extensor tendons of both feet being non-viable, the patient underwent bilateral below the knee (BKA) amputation on the 67<sup>th</sup> hospital

day. He remained paraplegic but with an improvement of sensation from L1–L3. Both BKA stumps were medium in length and healed well. The postoperative rehabilitation management centered on pre-prosthetic training. It was at this time of his rehabilitation process that Luzon was placed under Enhanced Community Quarantine because of the COVID-19 pandemic, and the rehabilitation services were temporarily suspended. The patient had to be discharged on the 74<sup>th</sup> hospital and post-burn day, and the 7<sup>th</sup> post-amputation day. The patient's SCIM was 49/100, with improvement in his ADLs of feeding, dressing, and grooming. He was able to sit upright but needed assistance during transfers and wheelchair propulsion. He was bladder- and bowel-continent.

Follow-up four weeks after discharge was done using telerehabilitation with the messaging application, Viber™. He presented with motor recovery in hip flexion and knee extension, now with a grade of at least 3/5, as well as in hip abduction, with a grade of at least 2/5. The patient was maximally assisted in bed mobility and in transfers from bed to wheelchair. On home environment assessment, it was seen that his home was located in an alley, 15 meters away from the main road, with a narrow doorway and a 3-inch elevation which are challenges to wheelchair mobility. There was limited space inside the home and the patient sleeps on a floor mattress. The bathroom had a chest-height drum for



**Figure 2.** Telerehabilitation session and home environment assessment and modifications.

water storage which was difficult for the patient to reach. The wheelchair provided by the local government was a manual folding wheelchair with fixed armrests (Figure 2). The patient also admitted to frequent episodes of irritability towards family members.

A total of eight teleconsultations were done for the patient. On the last teleconsultation, he was able to perform assisted bandaging for the stumps, do press-ups on his chair. He was also able to do independent bed mobility but still had to be carried by his caregiver to the wheelchair. He was carried from wheelchair to monobloc chair for bathing but was able to perform the rest of the activity independently by preparing his toiletries nearby and having a waist-height pail that he can reach with ease. He is able to propel the wheelchair independently at home but has not tried using it outside due to the quarantine measures in place. He has also been able to cook fried viands and rice and has been less dependent on his caregivers for food preparation.

Finally, the patient attributed his irritability to his inability to go out of the house to find a job suitable for him. He expressed a deep desire to provide for his family, and in the middle of the community quarantine, he started an online selling business. Telerehabilitation sessions always ended with group conversations with patient and his caregivers to ask about their current emotional state and screen for any red flag signs for depression and anxiety.

## DISCUSSION

Electrical injury, the 4<sup>th</sup> most common cause of admissions in burn units, is a highly distressing injury. Electrical burns present not only with skin and deep tissue involvement but also with multiple acute and chronic complications ranging from cardiac, cognitive to sensorimotor abnormalities.<sup>1,2</sup> Despite the expansive research on burn rehabilitation, there are only a few reported cases of electrical burns causing spinal cord injuries or extensive myelopathies. Though both conditions may happen with a concomitant fall from a considerable height there also have been reports of spinal cord injuries presenting in post electrical burn patients after a fall from a standing height.

Neurologic effects of high-voltage electrical burns have also been grouped according to time of onset – immediate appearing at the same time as the burn injury, early appearing within 5 days, and late-appearing after 5 days. Immediate effects are usually loss of consciousness, sensory abnormalities, and extremities weakness, which was all present in the patient. Other immediate effects are agitation, mania, confusion, amnesia, headache and convulsions, deafness, blurring of vision, respiratory paralysis, and tremors.<sup>3</sup>

Severe thermal injury in electrical burns targets areas with high resistance like skin, ligament, and bone, which are the usual entry or exit sites in the body. Electrical current, on the other hand, prefers to flow along with structures with low

resistance which are the muscles, nerves, and blood vessels. In this case, the entry point is the vertex of the skull, and exit points are the ankles, with severe injury of the extensor tendons leading to necrosis and eventual amputation. From the entry to the exit point, electricity is hypothesized to flow through the nerves, an area of low resistance.<sup>4</sup>

The theorized mechanisms of spinal cord injury after an electrical burn are 1) thermal damage within the nerve due to heat produced by the electrical current 2) vascular damage to vessels supplying the nerve causing thrombosis and hemorrhage 3) direct mechanical trauma from fracture or dislocation resulting from intense muscle spasm 4) radiation-like effect caused by changes in tissue protein following passage of an electrical current 5) buildup of electrostatic forces leading to violent tissue disruption. Of these mechanisms, the only one ruled out in the case is the third due to the lack of radiographic evidence of fractures or dislocations of the vertebra.<sup>5,6</sup>

The anatomy of the spinal cord and blood supply of each spinal segment will also help identify the area's most susceptible to ischemic injury. The anterior gray matter especially the anterior horn cell, which plays a vital role in motor functions, is very susceptible to ischemic injury due to vascular degeneration. In the cervicothoracic region, severe injury to small-sized vessels may lead to quadriplegia. The mid-thoracic (T4-T8) region is also vulnerable to ischemic injury. The lower thoracolumbar region of (T9-L5) has a relatively better blood supply due to the artery of Adamkiewicz, hence milder presentation and better recovery patterns may be observed.<sup>7</sup>

In case reports of electrical burns with an entry wound on the head and exit wound on the upper extremity, a patient with SCI usually will present with quadriplegia. While an exit wound in the lower extremity will present with paraplegia.<sup>3,8</sup> The latter pattern with paraplegia was observed in our patient with entry wounds on the vertex of the skull and exit wounds on the feet.

In terms of recovery patterns, patients with immediate effects of electrical injury or those that are apparent within 24 hours of the accident are usually transient. In addition, an incomplete spinal cord injury offers a better prognosis for motor and sensory recovery compared to a complete one. The same is true for cases of spinal cord injury without radiographic abnormality. They have a higher probability of improvement compared to those with imaging findings. There are reports of patients showing signs of recovery as early as 3 weeks. However, there are also contradicting reports of patients not showing any motor improvement even up to 3 years post-injury.<sup>8</sup>

The rehabilitation management will not be successful if our patient is demotivated. Hence, aside from addressing mobility and ADLs, it is also important to continuously screen and assess patients for red flag signs for emotional and psychological problems that may hamper their recovery. Studies show that people with disabilities are at a signifi-

cantly higher risk for suffering depressive symptomatology regardless of gender or age.<sup>9</sup> For spinal cord injury patients, who were previously active and productive suddenly become immobilized and unable to perform even the most basic functions. An instantaneous event leads to a life-long adjustment to disability. This places them in an overwhelming physical and emotional adjustment process.<sup>10</sup> Amputees, on the other hand, react to the surgery differently based on their experience. A previously bed-bound person who has been suffering from extensive burns of the lower extremity will see amputation differently from an Olympic athlete who will require emergency amputation. It has also been found that those who undergo bilateral amputations had a higher tendency for depression.<sup>11</sup>

In patients with spinal cord injury and amputation, there have been reports of patients suffering from severe depression, who were unresponsive to medical treatment and refused to cooperate during rehabilitation leading to multiple complications of immobility.<sup>12</sup> Contrary to what is expected, there are studies showing that people who receive rehabilitation services are more prone to depression because, in a rehabilitation setting, physical and emotional challenges are inevitable. Patients may be subject to pain, setbacks, and frustration when their recovery fails to progress in the manner and the speed that they expect.<sup>9</sup>

Finally, one of the biggest benefits of telerehabilitation, in this case, was the chance to observe the patient's environment and how he, with the rest of the family, moves around it. Treating the patient in the hospital was important but equally important is to see his usual environment, determine challenges in mobility or risk factors for accidents and suggest feasible modifications. These adjustments will bring the patient closer to the ultimate goal of returning to a safe home and being reintegrated in his community as a young adult who fulfills his role as a provider for the family.

## CONCLUSION

In patients with multiple disabilities, it is important to know the highest functional outcomes given their condition. The rehabilitation goals and management for each patient should always be assessed and must be tailored to address the needs of the patient whose medical, neurologic, surgical, and psychological condition may change at any point during the illness and recovery period.

### Statement of Authorship

All authors participated in the data collection and analysis and approved the final version submitted.

### Author Disclosure

All authors declared no conflicts of interest.

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