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Early Physiatry Involvement in Acute Complex Pediatric Spinal Cord Injury: Case Report

Zainab J Al Lawati*

University: Texas Tech University Health Sciences Centre El paso, USA

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***Corresponding author**: Zainab J Al Lawati, University: Texas Tech University Health Sciences Centre El paso, 4800 Alberta Ave El Paso TX 79905, USA

Abstract

Although it is a rare injury, the physiologic and psychosocial impact of spinal cord injury (SCI) in the child is dramatic and far reaching. Early Physiatry involvement is valuable to direct their care and facilitate their transition to the rehabilitation journey. We report a case of a 13-year-old-child who sustained a gunshot wound to the left chest resulting in a descending thoracic aorta injury and T5 fracture with apparent transection of the spinal cord that resulted in complete thoracic spinal cord injury. He had posterior thoracic fusion and segmental instrumentation from T3-7 with removal of bullet from gunshot wound. He also underwent left anterolateral thoracotomy with interposition graft to the thoracic aorta. Subsequently, he developed bilateral lower extremity compartment syndrome worse so in the right. He had right above knee amputation (AKA).

Physiatry was involved in his acute course. Pediatrics spinal cord injury and amputation rehabilitation goals were established. His autonomic dysreflexia, skin health, spasticity, neurogenic bowel and blabber, respiratory rehabilitation, latex allergy and spasticity management were optimized. His mental health was taken care of by psychology. He did not develop hypercalcemia. His right above knee amputation rehabilitation goals were addressed including phantom sensation, edema management and contracture prevention. A family conference was conducted prior to his transfer to a specialized pediatrics spinal cord injury rehabilitation hospital to address his rehabilitation needs and plan future care.

Significance: This report illustrates the significance of early Physiatry involvement in acute complex pediatrics spinal cord injury to explore rehabilitation needs early in the management course and prepare these children along with their caregivers for their rehabilitation journey.

Keywords: Intensive Care Unit (ICU); Glasgow Coma Scale (GCS); Spinal Cord Injury (SCI); Above Knee Amputation (AKA)

Introduction

Although it is a rare injury, the physiologic and psychosocial impact of spinal cord injury (SCI) in children is dramatic and far reaching. Although most review articles of pediatric spinal cord injury focus on the diagnosis and management, the role of physiatry in early intervention and subsequent rehabilitation care has received significant attention and has been applied in leading institutions. Early involvement of physiatry has been shown to improve acute care and facilitate the patient's transition to the rehabilitation journey. This case report describes a complex pediatric SCI resulting from a gunshot wound. Early physiatry involvement in the intensive care unit (ICU) facilitated the acute management, addressed medical complications post-SCI, and prepared the family for the upcoming rehabilitation journey.

Case Presentation

A 13 year-old male sustained a gunshot wound to the left chest resulting in a descending thoracic aorta injury and T5 fracture. Imaging showed a complete transection of the spinal cord at that level. Upon initial presentation in the emergency department, his Glasgow Coma Scale was 7T and there was no anal tone and no sensation noted below the nipple line. He had no movement in the bilateral lower extremities. Neurosurgery was involved, and he had posterior thoracic fusion C3-7, segmental instrumentation of thoracic spine T4-7, arthrodesis of T3-7, and removal of the bullet from the gunshot wound. Vascular surgery was involved, and he underwent left anterolateral thoracotomy with interposition graft to the thoracic aorta. Subsequently he developed bilateral lower extremity compartment syndrome requiring four-compartment fasciotomy of the right lower extremity and limited fasciotomy of the left lower extremity. However, most muscles and tissues in the right lower extremity were completely necrotic, and therefore he had right above-knee amputation.

The patient's initial ICU course was complicated with pneumonia that was managed with antibiotics. He was

subsequently extubated, and a complete SCI evaluation was conducted to determine the completeness and level of injury. He sustained T4 AIS A with right above-knee amputation secondary to compartment syndrome. His SCI-related medical complications were addressed in the ICU. His autonomic dysreflexia (AD) was manifested in headaches, facial flushing and sweating above the level of injury, and goose bumps below the level of injury. His AD was managed by removing the trigger that was emptying the bladder. No medication was required. His calcium level was regularly monitored, and he had no hypercalcemia. His neurogenic bladder was managed with an in/out catheter, and the family and patient were guided in how to use the catheter. His neurogenic bowel was managed with laxatives and digital rectal stimulation with the aid of his gastrocolic reflex. He was in spinal shock throughout his ICU stay, and no medical management for spasticity was required. Physiotherapy was involved in optimizing the passive range of motion of his bilateral lower extremities and the active range of motion of his bilateral upper extremities. He developed latex allergy, which manifested in shortness of breath and a rash over his body after being examined with latex gloves. The latex allergy was managed with supportive measures and by removing the trigger. His respiratory care was managed with incentive spirometry. Psychology was used to address his emotions and collaborate with family members to support his mental health. No medications were required. Skin health was maintained with frequent skin checks, changing positions as per SCI guidelines, and proper wound care at the surgical area.

With regard to his right above-knee amputation, a shrinker was applied from post-op day one to control the stump swelling. He had phantom sensation but no pain, and therefore no medication was required. Proper positioning education was provided to the nursing staff in the ICU as well as the family to prevent contracture formation. Post-op wound care was performed by the wound care nurse. The surgical wound healed properly.

Family conferences were conducted regularly to update the family with his medical status and provide counseling with regard to his injury level and expected outcomes. In his final family conference, a complete rehabilitation plan was laid out, and the family was educated on the rehabilitation journey and follow-up plan.

He was discharged to a rehabilitation facility with expertise in pediatric SCI rehabilitation. A plan for follow-ups at our institution for outpatient care has been arranged.

Discussion

SCI is an acute insult to the spinal cord that can be physically, mentally, and socially debilitating. The incidence of SCI in the pediatric population is estimated at below 2% per year, although SCI can be a major cause of morbidity. SCI in adolescents is more common among males than females by a ratio of 4:1. The most common cause of SCI in children and adolescents is motor vehicle crashes, followed by violence and sports [1]. Other causes of SCI in children include non-accidental traumas and inherited conditions, such as spinal stenosis seen in skeletal dysplasia, and rheumatological conditions, such as juvenile rheumatoid arthritis.

Pediatric SCI is unique in that it is a life-long journey that not only affects patients' physical growth and mental health and requires adaptation for successful community integration, but also affects their families. Family involvement is therefore vital for successful rehabilitation, and proper education is important to ensure a smooth process with proper management of medical complications that affect patients' medical status and cause caregiver burnout. Early rehabilitation in pediatric SCI is required to ensure optimal quality of life as the child integrates into their community.

Studies into early rehabilitation in ICU are limited, but data are emerging for adults. Early rehabilitation can help reduce the time ICU patients spend on ventilators and in ICU [2]. Proper pulmonary rehabilitation in ICU may reduce their length of stay by up to 4.5 days and reduce their time on ventilation by 2.3 days [3]. Patients who have undergone rehabilitation in ICU rate their quality of life better in terms of health [4]. Rehabilitation leads to improved recovery and better overall outcomes in a number of critical conditions, including stroke, burns, traumatic brain injury, SCI. This reduction in the length of stay saves providers significant operating costs: more patients can be treated if former patients do not need to return, and reimbursement denials are far fewer. Advocating for a "culture of early mobilization patients in ICU" promotes early rehabilitation for the eligible patients through multidisciplinary education and engagement.

Medical complications related to pediatric SCI are unique and describing them in detail is beyond the scope of this article. There are certain medical complications that occur in ICU, however, and managing them early can prevent further complications and ensure early rehabilitation takes place.

Spasticity: The American Academy of Neurology (1990) defines spasticity as "a motor disorder that is characterized by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex, as one component of the upper motor neuron syndrome" [5]. There are upper and lower motor neuron signs and symptoms of spasticity with upper motor manifestations appear first [6]. It is worth mentioning that in the acute phase of SCI, spasticity might not be prominent until the spinal shock subsides. This might take weeks to months. The presence of the deep plantar response is important in concluding that the spinal shock is over. Clinical assessment of spasticity begins with a comprehensive clinical evaluation by an experienced interprofessional team. Management with non-pharmacological measures and range-of-motion exercises is important. In the pediatric population, management of spasticity with medications requires frequent weight evaluation and adjustments, as the child's weight might change and the medication might become ineffective.

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Dysautonomia (AD and temperature regulation): Lesions of the spinal cord at the T6 level and rostral result in autonomic nervous system dysregulation, manifesting as AD. AD is defined as a systolic blood pressure increase of 20–40 mm Hg with symptoms such as facial flushing, headaches, and piloerection, although children younger than 5 years rarely show these symptoms [7]. Pediatric patients are unique in that they may have more difficulty than older patients in communicating the changes associated with AD [7]. Physiatrists should be meticulous in looking for AD with timely intervention. Family education in AD assessment and management for parents/caregivers and patients are important in avoiding serious complications. Pediatric SCI patients are also prone to poikilothermia, in which the patient's body assumes the temperature of the external environment. Attention should be given so that the environment surrounding the patient does not undergo extreme weather changes.

Respiratory rehabilitation: Respiratory complications from SCI are significant causes of morbidity and mortality in children, especially in children with cervical SCI [8]. Although they may require initial ventilator support, many of these children are weaned from this support [8]. Children who cannot be weaned require long-term ventilator support and phrenic nerve pacing and secretion management early in their recovery phase is encouraged.

Neurogenic bladder: The primary goal of neurogenic bladder management in pediatric SCI is to maintain social continence, prevent life-threatening complications, and treat urinary tract infections. Self-catheterization is considered the standard of care, and children with SCI should be trained as early as the age of 3 years with the goal of independent self-catheterization at the age of 5–7 years. The children should be diligent in identifying early signs of urinary tract infections, which include worsening spasticity, change in urine color, and/or hematuria. Surgical interventions are available, including Mitrofanoff, to maximize independence in self-catheterization [9].

Neurogenic bowel: The goals of neurogenic bowel management are similar to those of neurogenic bladder management, namely maintaining social continence and preventing bowel obstruction and its associated morbidity. Depending on the level of injury, the child might need upper or lower motor neuron bowel management with some adaptations. The use of retrograde irrigation systems, such as cone enemas or inflatable rectal catheters, has been more helpful more in the pediatric SCI population [10].

Hypercalcemia: Hypercalcemia is a serious complication that affects around 23% of children with SCI, particularly adolescent males. The classic symptoms of hypercalcemia can be summarized as "stones, bones, abdominal groans, thrones, and psychiatric overtones." Treatment is generally aggressive hydration with furosemide diuresis, although bisphosphonates may also be considered [11].

Pressure Ulcer: Shriners Hospitals for Children, Chicago, reported around 21% prevalence in their pediatric SCI population, with up to 55% of children reporting pressuring ulcers within the first decade after injury. The guidelines for pediatric SCI are similar to those for adults, with frequent re-positioning, skin checks, and optimization of protein intake [12].

Vascular complications: Deep venous thrombosis (DVT) is a rare complication in children with SCI. The risk of DVT in children younger than 12 years is low enough that chemoprophylaxis is not routinely recommended, unless other significant risk factors are present. There is no difference in DVT prophylaxis for pediatric and adult SCI patients in the current clinical practice guidelines [13].

Immunologic complications: Approximately 6% to 18% of all children with SCI are allergic to latex, with the younger children more prone to developing latex allergy. Increased exposure also plays a role in developing latex allergy, and exposure prevention is recommended [14].

Orthopedic complications: Patients who have SCI before their adolescent growth spurt have a high likelihood of later developing scoliosis, and regular screening is recommended.

Family education: One of the important factors in the successful rehabilitation of pediatric SCI is family and caregiver education. The rehabilitation plan should be designed to involve all family members and incorporate activities that the family enjoys. Caregiver burnout should be addressed early, and alternatives should be offered based on the support available. As the child with SCI grows and becomes an adult, vocational rehabilitation is vital to ensure a smooth entry to the workforce.

Amputation: It is uncommon to have amputation as well as pediatric SCI. In our case, the patient required right above-knee amputation due to compartment syndrome. The application of basic measures of amputation rehabilitation to address phantom sensation, edema management, proper positioning, and wound care was fundamental to ensure the optimal healing process. Whether to fit the patient with passive prosthesis for cosmetic reasons would depend on his rehabilitation progress and clinical needs.

Conclusion

This case reports a complex pediatric spinal cord injury secondary to a gunshot. His recovery has been optimized surgically, medically and from rehabilitation perspectives. This case illustrates the importance of early physiatry involvement in acute complex pediatric SCI to explore rehabilitation needs early in the management course and prepare these children along with their caregivers for their rehabilitation journey.

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