Fall 2019

Physical Therapy Management and Individualized Rehabilitation of Patient with Incomplete Spinal Cord Injury: A Case Report

Megan Shryack
University of Iowa

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Megan Shryack

DPT Class of 2019
Department of Physical Therapy & Rehabilitation Science
The University of Iowa

Abstract

Background: Incomplete spinal cord injury can present itself very differently depending on the level and severity of the injury. Many factors, such as weight bearing restrictions and co-morbidities, need to be considered when choosing intervention techniques. Thus, the purpose of this case report is to provide an example of successful multi-interventional rehabilitation of a patient with incomplete level spinal cord injury despite complicating secondary factors such as non-weight bearing limitations on his left lower extremity. **Case Description**: The patient was diagnosed with C4 ASIA C level incomplete spinal cord injury following a motorcycle accident. The patient sustained multiple injuries including ligamentous disruption between C5-C6 at the anterior longitudinal ligament and posterior longitudinal ligament, along with multiple other fractures. He underwent multiple surgeries including anterior cervical disc fusion and closed reduction with external fixation to heal other fractures. He was transferred to an inpatient rehab hospital and later transferred to subacute rehabilitation center for continued rehab. The patient had orders to maintain non-weight bearing status to left lower extremity due to his fractures. **Outcomes**: This report compared levels of assistance at initial evaluation and discharge. **Discussion**: This case report supports the multi-interventional rehabilitation approach to incomplete spinal cord injury while considering external factors that complicate patient care such as weight bearing restrictions. It allows clinicians an example of how to abide by restrictions without compromising patient's ability to meet goals and increase lower extremity strength with incomplete spinal cord injury.

Keywords: incomplete spinal cord injury; lower extremity fracture; physical therapy; rehabilitation

Background and Purpose

Spinal cord injury occurs when the vertebrae surrounding the spinal cord become damaged by way of fracture, dislocation, burst, compression, hyperextension or hyperflexion.[1] The spinal cord coordinates body movements and sensations throughout the body. When injured, the cord is unable to receive or relay messages between the brain and the body, therefore resulting in decreased motor, sensory, and/or autonomic dysfunction depending on the extent of the injury.[1] After injury an examination will take place and the patient will be assigned a level of injury and it will be determined if the injury is complete or incomplete. A complete injury indicates lack of total sensory and motor function below the level of injury.[1] An incomplete injury means the ability of the spinal cord to convey messages to and from the brain is not completely disturbed.[1] Some sensation and movement is possible below the level of the injury.[1]

The most common causes of spinal cord trauma include motor vehicle accident and falls.[2,3] Automobile and motorcycle crashes made up 38.3% of all spinal cord injuries from 2005-2011, which is the largest category among causes of spinal cord injury.[2,3] A common associated injury with motor vehicle accidents include fractures and musculoskeletal injuries.[4] A study done in Taiwan surveyed the major injury patterns associated with traffic accidents and found orthopedic fractures were the most common injuries, accounting for 29.36% of traffic-accident-related hospitalizations.[4] However, despite similar injury patterns associated with car and motorcycle accidents, there is a lack of evidence in the literature that combines management of musculoskeletal injuries such as fractures with traumatic incomplete spinal cord injury.

Rehabilitation of a fracture requires medical attention to ensure proper healing and alignment of the bone. If reduction of the fracture is needed, it can be done manually, or for more serious fractures, surgical procedures such as open reduction internal fixation (ORIF) may be necessary to ensure all bony pieces are aligned correctly so healing can occur.[5] Often after lower limb fracture, the bone also needs to be immobilized to ensure proper healing.[5] There are different options for immobilization that will be recommended by the doctor. After a lower extremity fracture, the doctor may limit the amount of weight that can be put through the leg.[5] The weight bearing restrictions must be followed to ensure the patient does not place too much stress on the healing bone. Physical therapy may be initiated following a fracture to promote return to prior function as quickly as possible.[5] This may include instruction on using an assistive device if needed, and instruction on exercises to improve endurance and strength to muscles around the fracture site to overcome the negative effects of immobilization.[5] Once cleared, PT can also help to improve functional mobility as tolerated. Exercises for improving ROM and strength are also started once the patient is able to tolerate activity. General healing time for bone is 6-8 weeks after fracture.[5]

Rehabilitation from spinal cord injury is a lengthy and complicated process that requires the expertise of many health care professionals.[6] It begins with admission to hospital and stabilization of patient's neurological state. The aim early on in rehab is to prevent complications that may occur, therefore passive exercises are done routinely to prevent contracture and stiffness and maintain functional capability.[6] Physical therapists also pay close attention to positioning of joints. It is important to start strengthening muscles with volitional activation early on in treatment to attain maximal level of function, especially muscles of the upper extremities as needed for transfers.[6] Orthostatic hypotension is common in patients with spinal cord injury, therefore tolerance to upright positioning will be integrated into therapy and then exercises for sitting balance and core stabilization will be initiated as the patient is able to tolerate the upright postures.[6] Also, once the patient is able to tolerate upright positioning, transfer training, training with assistive devices, and gait training may be initiated based on patient's level of injury.[6] Therapy regarding spinal cord injury is largely dependent on level of injury and available strength and sensation, therefore a patient-centered approach is required.

Even though spinal cord injury and fractures have similar root causes, the treatment approach may differ in terms of physical therapy management. There is not much evidence on how to manage both conditions simultaneously in the literature. Like any treatment approach in physical therapy, multi-interventional, task specific practice, focusing on functional mobility and strength training is a mainstay in rehabilitation of incomplete spinal cord injury. However, incomplete spinal cord injury with associated lower extremity fracture complicates the rehabilitation process as clinicians need to be creative in their treatment approaches to provide the same level of multi-dimensional care while respecting non-weight bearing restrictions due to associated trauma during the injury. This case report is designed to illustrate an example of how musculoskeletal and neurological conditions collide. However, the treatment approach remains multi-interventional and patient specific regardless of the nature of the injury. While rehabilitation for incomplete spinal cord injury is inherently personalized depending on the level and severity of the injury, additional restrictions and co-morbidities can further complicate clinical decision-making. Thus, the purpose of this case report is to highlight the successful multi-interventional rehabilitation of a patient with an incomplete level spinal cord injury despite initial non-weight bearing limitations.

Case Description: Patient History and Systems Review

The patient is a 54-year old male who was involved in a motorcycle accident in which he was hit from behind at near highway speeds and ejected off his motorcycle. He lost consciousness during the accident. He sustained multiple injuries including ligamentous disruption between C5-C6 at the anterior longitudinal ligament and posterior longitudinal ligament which ultimately led to his spinal cord injury. American Spinal Injury Association impairment scale (ASIA) testing one-month post injury indicated the patient was C4 ASIA C incomplete injury, which demonstrated he had sensory and motor innervation below the level of injury. He also sustained fracture of his left proximal tibia and fibula, left Lisfranc fracture, left medial malleolus fracture, left orbital wall fracture with bilateral subconjunctival hemorrhages, left nasal fracture, and multiple facial lacerations. Following stabilization in hospital, he underwent C5-C8 anterior cervical disc fusion to stabilize his cervical spine after ligamentous instability. He also underwent closed reduction with external fixation of his left proximal tibia fracture, closed reduction with splinting of his left malleolar and midfoot fractures, and an inferior vena cava filter placement. While in the hospital, the patient indicated ongoing depression and anxiety. Following his stay in the hospital, the patient was transferred to an acute rehabilitation hospital 3 weeks following his accident for ongoing medical care. After no longer needing hospital level care, the patient was discharged to a specialized facility for spinal cord injury as he required ongoing, intensive rehabilitation. His past medical history included hip osteoarthritis, L5-S1 canal stenosis, nicotine dependence, incidental findings of pulmonary nodules, and hypervascular lesion of the liver. In regard to social history, the patient lived at home with his two 20-year old sons. He was divorced but still on good terms with ex-wife as she was available for emotional support as needed. He has 5 steps to enter his home with bathroom and bedroom on the main level with tub shower. He has a 2 pack per day smoking history for the past 10-15 years and drinks sporadically throughout the week. He occasionally smokes marijuana.

Clinical Impression and Examination

The primary problem in this case is the lack of evidence available for incomplete spinal cord injury with confounding additional complications such as lower extremity fractures. The list of diagnoses available for this patient include C4 incomplete ASIA C level spinal cord injury, upper extremity contractures of wrist and fingers, spasticity, and lower extremity fractures. Due to left lower extremity injuries sustained in the accident, the patient was given left lower extremity non-weight bearing restrictions when initially evaluated at the subacute rehabilitation center. During the course of treatment at the subacute rehabilitation center, subsequent CT images were taken in which the doctor allowed the patient to advance to 50% weight bearing through his left lower extremity 8 weeks after his accident. Despite the weight bearing restrictions in his left leg, the patient had been able to continue to improve his bilateral lower extremity strength while at the rehabilitation center. Therefore, increasing strength to ultimately aid in improved functional mobility as a long-term goal upon discharge to home. The challenge had been how to continue to strengthen the left leg while abiding by the weight bearing restrictions. Therefore, a multi-interventional approach of strength training in multiple domains was taken. Upon examination, the patient had variable sensation of light touch and sharp/dull distinction. He had significantly diminished sensation through his right lower extremity and trunk as compared to left, however, on his left side, the L2-S2 dermatomes were unable to be tested due to his left lower limb splint and brace. He was able to detect sensation in S3-S5 dermatomes with intact voluntary anal contraction and deep anal pressure. Initial muscle test scores are listed below in Table 1.

Table 1. Manual Muscle Test Score at Initial Evaluation

Muscle Strength (0-5 on MMT scale) Supine position	Left	Right
Wrist flexors	3	3+
Wrist extensors	3-	4-
Elbow extensors	3+	4-
Elbow flexors	4-	4
Ankle plantarflexors	Unable to be tested	3+
Ankle dorsiflexors	Unable to be tested	3
Knee flexors	1	1+
Knee extensors	1	1+
Hip flexors	1	1+

The patient also had decreased left knee range of motion which was limited to 75 degrees of flexion upon evaluation due to immobilization of his left lower extremity after left tibia fracture. In terms of assessing functional level on initial evaluation, the patient was taken through a range of functional mobility tasks and assessed according to the level of assistance required for each task. He required minimal assistance for rolling in his bed with the use of bed rail and due to increased tone and spasticity through bilateral hands, he required minimum assist to position his hand on the bed rail as he has limited volitional finger extension to overcome the flexor tone. Due to decreased strength, the patient required maximum assist to move from sitting to supine to sitting. Help was required to manage the weight of his left lower extremity immobilizer and support torso. At evaluation, the patient had just begun trialing slide board transfers. He required increased verbal cueing and moderate assistance of one to perform slide board transfer to therapy mat during evaluation. He was limited by lack of upper body strength and mobility of his hands. He was not safe to be performing this slide board transfer with nursing staff, therefore Hoyer lifts were used for safety in his room on site. Sit to stand, standing, ambulation, and floor transfers were not able to be assessed at evaluation due to need for Hoyer lift, lack of right lower extremity strength, and initial non-weight bearing status in left lower extremity. In terms of assessing his balance, he was able to perform seated static balance with contact guard assistance needed due to unsteadiness. For mobility, the patient was navigating his power wheelchair with supervision/standby assistance as he demonstrated ability to safely negotiate obstacles. The definitions for levels of assist are found in Table 2. This patient represents a good candidate for this case report because he exemplifies how musculoskeletal conditions need to be treated concurrently with neurological conditions. Awareness of all systems represented by the patient leads to comprehensive care by the physical therapist to be able to help the patient achieve their goals.

Interventions

One of our main goals with this patient was to increase strength in the upper and lower extremities to be able to gain independence in functional mobility. However, the challenge had been how to continue to strengthen the left leg while abiding by the weight bearing restrictions. Therefore, a multi-interventional approach of strength training with open chain exercises originally and progressing to closed chain exercises while maintaining 50% weight bearing was implemented. The emphasis was to increase strength in his legs to eventually perform stand pivot transfers and gait training in short distances to increase independence at home upon discharge. By doing so, we utilized many mat exercises to target specific muscle groups. Modified bridges were done to increase gluteal strength while maintaining left lower extremity non-weight bearing restrictions. By doing so, the patient flexed his right knee into the bridge position on mat table while an exercise ball was placed under the left lower limb and the patient was instructed to engage his gluteal muscles while pushing through his right lower extremity and pushing down through the exercise ball with his left lower extremity. Open chain exercises were performed on the mat table such as straight leg raises, sidelying hip abduction clam shells, and sidelying hip flexion, hamstring curls, and hip extension with gravity eliminated by supporting the left lower extremity on a table surface in which the limb could move through the appropriate range of motion. For left quadriceps strengthening, the patient preformed short arc quad and long arc quad exercises as well as supine leg extension with left leg supported on exercise ball with resistance band pulling limb into hip flexion to provide some resistance. A Total Gym apparatus was used which allowed the patient to perform partial body weight squats depending on the angle of elevation of the system. The Total Gym is a leg press device that allows the patient to change the amount of body weight they must press based on the angle at which that are positioned on the seating surface with respect to horizontal. With each exercise, we had to pay close attention to how we could modify different exercises in order to maintain the patients weight bearing restrictions. When he was non-weight bearing on his left lower extremity, we were unable to use his left leg during the Total Gym squatting exercise, however, as he advanced to 50% weight bearing per physicians orders, we were able to allow him to participate in double leg press and single leg press with the left leg while making sure he did not exceed lifting 50% of his body weight based on the angle of the device with respect to horizontal. As the patient was advanced to 50% weight bearing through his left leg, we were also able to initiate gait training using the Zero G body weight support system by supporting 50% of his body weight with the harness apparatus. The Zero G gait and balance system is a robotic body weight support system on an overhead track for practicing a wide range of activities without the risk of falling. This piece of equipment allowed us to work on gait training and lower extremity strengthening in a safe and controlled environment. The device allowed us to support half of the patient's body weight so we were able to ambulate 150 ft within the lower extremity restrictions. It also allowed our patient to practice sit to stand transfers with body weight supported to allow for safety. We were able to work on these sit-to-stand transfers with the goal of advancing to stand pivot transfers within the weight bearing precautions. As the patient was able to develop more strength in his right lower extremity, he was instructed to push through his right leg and use upper extremities on a front wheeled walker with two platform attachments to support his forearms to assist himself into a standing position. Toward the end of the plan of care, the patient was performing stand pivot transfers within his precautions, which negated the need for a Hoyer lift to be used in transfers to and from commode/shower chair and power wheelchair, making our patient more independent in his transfers and cares.

Outcomes

Multiple functional tasks were assessed as the primary outcomes for this patient. These included a series of functional activities and mobility tasks evaluated at initial evaluation and discharge such as rolling, sit to supine to sit, even surface to surface transfers, vehicle transfer, sit to stand, seated and standing balance, wheelchair mobility, ambulation, and stair negotiation. There are multiple functional assessments used in the literature and while there are many operational definitions used in practice, these may differ regionally, based on education, and/or may be interpreted differently due to their often subjective nature. The levels of assistance that were used to document on the patient in this case report was based off of the Functional Independence Measure (FIM). The FIM is the most widely used functional measure and was initially developed to evaluate functional ability in daily activity.[7] It represents the burden of care of a disability and is designed for use in many disability groups.[7] The FIM assessment is composed 18 items which includes 13 motor tasks and 5 cognitive tasks.[8] These 18 items are further divided into 6 areas of function which includes self-care, sphincter control, transfer tasks, locomotion tasks, communication, and social cognition.[7] All 18 items are scored using a seven-point ordinal scale based on the amount of assistance that is required for the patient to perform each activity, with a score of 1 reflecting full assistance and 7 being complete independence.[7] Higher scores on the FIM denote patients that have a higher level of independence and require a small amount of assistance.[9] The FIM levels of assist used in this case report are described in Table 2.

Table 2. Functional Independence Measure Levels of Assist.[10]

ASSIST LEVEL	ABREVIATION	FIM LEVEL	DEFINITION
COMPLETE INDEPENDENCE	I	7	All tasks are performed safely without modification, assistive device or aids and within a reasonable time
MODIFIED INDEPENDENCE	Mod. I	6	One or more of the following are true about activity: - Requires assistive device - Takes more than reasonable amount of time - There is a safety (risk) concerns No helper required
STANDBY ASSISTANCE SUPERVISION OR SET-UP	SBA or S	5	Requires no more than standby, cueing or coaxing without physical contact or helper sets up needed items or applies orthoses
CONTACT GUARD ASSISTANCE	CGA	4	Variation of minimal contact assist where subject requires contact to maintain balance or dynamic stability
MINIMAL ASSISTANCE	Min A	4	Requires no more than touching and expends 75+% or more effort; assistance is needed to lift one limb
MODERATE ASSISTANCE	Mod A	3	Requires more help than touching or expends 51 to 75% of the effort; assistance is needed to lift two limbs
MAXIMAL ASSISTANCE	Max A	2	Subject expends 26-50% of effort
TOTAL ASSISTANCE	Total A	1	Subject expends less than 25% of effort; two or more provide assistance

Levels of assistance used in the FIM scoring can generate conversation about the objective nature of using these terms. It is up to the discretion of the therapist to use their clinical judgement to justify what level of assistance their patient falls into at initial evaluation and discharge with the supporting documentation. Regarding reliability of the FIM, Cronbach's alpha is high for all FIM total scores and subscales (>.70).[7] Reliability coefficients are nearly all high (alpha >.90) for admission and discharge total scores, and only the locomotion subscale is found to have low internal consistency.[7] The inter- and intra-rater reliability is high for the FIM (r= 0.81-0.96).[7] Regarding sensitivity to change, the FIM items lack adequate sensitivity to detect changes associated with return of function following SCI.[7]

Face, content, construct, discriminant, and criterion-related concurrent validity are all high for the FIM.[7] However, the clinical utility of the FIM for measuring functional recovery in SCI is questionable as some studies have failed to detect changes in function in patients with SCI over time.[7] With high validity and reliability, the FIM is currently the most widely used clinical evaluation tool for functional mobility in the SCI population, however the biggest limitation in regard to SCI is the insensitivity to change.[7] Therefore, it is hard to detect small but functionally significant amounts of change in the SCI population using this tool.[7] There is limited research indicating MCID information regarding the SCI population in the literature. However, within the stroke population, it was determined the FIM change scores associated with MCID were 22, 17 and 3 for the total FIM, motor FIM and cognitive FIM, respectively.[11]

The levels of assistance described above in Table 2 were used to in the current case report to document functional assistance at initial evaluation, intermittent time periods during plan of care, and discharge. Thoroughly documenting progress throughout the plan of care demonstrates need for skilled therapy services to insurance companies which allows patients to continue to get needed rehabilitation services. In this case report, the improvement in level of assistance rating between 1 and 7 in the various outcomes demonstrates why intensive, patient-specific, skilled physical therapy services were required in the care of our patient. Table 3 compares the assistance levels given at initial evaluation compared to what the patient progressed to upon discharge home with caregiver support.

Table 3. Levels of Assistance given at Initial Evaluation compared to Discharge

	INITIAL EVALUATION	**DISCHARGE**
ACTIVITY	**Functional Assist Level:**	**Functional Assist Level:**
ROLLING	Minimum assistance with bed rail	Modified independent in bed
SIT TO SUPINE TO SIT	Maximum assistance	Minimum assistance
SURFACE TO SURFACE TRANSFER	Moderate assistance (slide board)	Minimum assistance (stand pivot transfer)
SURFACE TO SURFACE – VEHICLE	Not yet assessed	Minimum assistance – slide board
SIT TO STAND	N/A – Left lower extremity non-weight bearing status	Minimum assist with bilateral platform FWW
FLOOR TO CHAIR	Dependent	Dependent – Hoyer
SEATED BALANCE	Contact guard	Modified Independent
STANDING BALANCE	N/A – Left lower extremity non-weight bearing status	Minimum assist with bilateral platform FWW
WHEELCHAIR MOBILITY	Supervision/standby	Modified independent
AMBULATION	N/A – Left lower extremity non-weight bearing status	Minimum assist in Zero G
STAIRS	N/A – Left lower extremity non-weight bearing status	N/A – 50% partial weight bearing on left lower extremity

The patient demonstrated significant improvements in functional mobility that allowed for independence in many aspects of his lift over the course of 12 weeks in subacute rehabilitation center prior to discharge home. In comparing outcome data from initial evaluation to discharge, the patient improved in all functional mobility outcomes. As stated above, many strengthening exercises were performed to assist in gaining independence with mobility, however, it is also worth noting that task-specific repetitive practice of the functional skill was performed frequently in therapy sessions to work on techniques to improve these outcome measures. In regard to aspects of bed mobility, the patient was able to achieve modified independence in rolling in bed. He was able to achieve successful left lower extremity management by volitionally pulling his knee into a flexed position to aid in rolling which helped him to become independent with the task. Rolling is a big accomplishment for our patient as he was able to roll himself overnight without assistance from nursing staff for pressure relief. This takes the burden of care off his sons whom he lives with currently to have to roll him during the night. For sitting to supine to sitting edge of bed, he advanced to minimum assistance needed. For the supine to sitting transfer, he did not need any touching assistance, however during the sitting to supine transfer he was limited by complaints of left hip pain and therefore could not lift his left leg completely onto bed without minimal help. He improved in this outcome measure from maximum assistance needed due to lack of trunk and lower extremity strength at evaluation. Transfers were a significant outcome for our patient. Throughout majority of his plan of care, he worked on slide board transfers since he had non-weight bearing restrictions. However, as he was able to tolerate 50% weight bearing through his left leg and increased lower extremity strength, he began stand pivot transfers with a standard walker with two forearm supports attached. He required minimum assistance for sit-to-stand and stand pivot transfer as he primarily pushed through his right leg and both arms on the platforms to pivot between chair, mat, and commode surfaces. The ability for him to successfully perform this stand pivot transfer negated the need for a Hoyer lift to be in the home for transfers to the commode and shower chair since he was unable to slide board to either. He also improved from moderate assistance with slide board transfers to mat table to contact guard assistance when transferring in and out of bed. This also helps to take the burden of care off his caregivers as he does not need lifting assistance to transfer in and out of his power wheelchair. However, he will need assistance present to transfer onto shower chair for safety reasons. In terms of other outcome measures, the patient demonstrated independence with dynamic sitting balance without use of his arms for support. This increases his ability to reach for objects in his environment and resist perturbations. For static standing, he achieved minimum assistance with using his bilateral platform walker as he was able to stand for greater than one minute. The assistance was needed to achieve standing position, but once in standing position, he did not require any external assistance during static stance. Standing could not be assessed previously due to his restrictions and lack of strength, therefore this was a big achievement for our patient. A goal for our patient was to be able to walk in therapy. He was able to achieve this goal with great pride as he walked 150 ft in the Zero G body weight support system without any external assistance to complete the stepping motion on either leg. He was able to use his arms on an eva walker to off load weight when in stance phase on his left leg. After discharge, our patient was scheduled for outpatient therapy in his hometown in which he will continue to work toward his goals of walking independently.

Discussion

The interventions discussed above helped to target the treatment of a patient with incomplete spinal cord injury along with musculoskeletal limitations. A comprehensive treatment approach was needed to address the patient's goals of increasing strength and becoming more independent in functional mobility while keeping in mind the restrictions that went along with this case. There is limited research evidence that combines incomplete spinal cord injury and associated lower extremity fractures when addressing treatment interventions. When looking at incomplete spinal cord injury in isolation, a systematic review by Wessels et al., (2010) concluded there is evidence to support subjects with motor incomplete spinal cord injury reached a higher level of independent walking after over-ground training, compared with body weight-supported treadmill training as measured by the FIM locomotor category.[12]

The subgroup analysis revealed that this difference was only significant for subjects with ASIA Impairment Score (AIS) C or D.[12] It was reported that body weight support gait training can start before participants are able to fully bear weight, prior to developing adequate motor control, and with greater safety and less fear of falling.[12] This conclusion was supported in this case study as our participant was able to utilize over ground gait training with the Zero G body weight system as an intervention with the goal of reaching a higher level of independent walking prior to full weight bearing capacity. Although the outcome from this systematic review supports the use of over-ground training as compared to body weight-support (BWS) treadmill training, it was noted that all participants with subacute SCI in all training groups (over-ground training, BWS treadmill training, and robotic gait training) improved walking velocity and walking independence, and the participants with the greatest impairments seemed to benefit the most from BWS.[12] The emphasis on task-oriented training in regard to over-ground training could give a possible explanation for its effectiveness compared to other forms of gait training.

In regard to orthopedic trauma of the lower extremity, diminished strength is very common. Loss of strength contributes to rapid deterioration in function and high rate of repeat falls.[13] Multiple randomized controlled trials show that both community and home-based strength-training regimens moderately but significantly improve strength, balance, and functional mobility 6-9 months following hip open reduction with internal fixation (ORIF).[13] Also, strength training will provide long-term reduction in perceived difficulty completing activities of daily living as compared to controls.[13] This provides evidence to the strength training exercises that were used in this case report to improve functional mobility outcomes following lower extremity fractures. Wolff's Law further supports our interventions as it states that bone adapts to the mechanical forces placed on it.[13] Whether the forces be from open chain strengthening exercises as stated in the interventions section or load bearing activity such as leg press and gait training activities, it puts mechanical stresses on the bones which allows for positive adaptations. This research supports the need for multiple stresses to be applied to the healing bone for full recovery to be made, despite the associated co-morbidities present in the patient.

This case report was designed to illustrate the thought process associated with a multi-interventional approach to patient care. The thought process for this case was aimed at improving strength and range of motion initially as able within the non-weight bearing restrictions to promote volitional return and bone healing in our patient. Followed by advancing the patient through body weight supported exercises and gait training as able. The implications this case report poses to physical therapy practice is that there may not be enough evidence that supports traumatic neurological injuries associated with musculoskeletal injuries. Each patient case is unique in its own way, but many patients sustaining traumatic injuries damage more than one system, which needs to be highlighted more frequently in the literature. However, when looking at intervention techniques for lower extremity injury and spinal cord injury separately, there are many overlaps in research in regard to intervention approaches including strength training, range of motion, and gait training as tolerated.

The case report also implies one way in which physical therapists are able to provide documentation to justify the need for continued therapy services for patients with complex injuries. The goal for in this case was to provide the patient with interventions to facilitate independence in functional mobility tasks to support discharge home with caregiver support. An argument can be made that interpretation of levels of assistance outlined in this case may allow for difference of interpretation among different clinicians. However, it was highlighted that the FIM has high validity and reliability in spinal cord injury populations. More research may need to be done to provide additional objective measures in which neurological populations may be assessed from baseline to discharge to gain additional information related to progress gained during physical therapy.

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