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## Chronic spinal cord injury: A life changer, a disease process rather than an event and its rehabilitation

**Aafreen, Ramakant Yadav, Suraj Kumar, Sohrab A Khan and Sandeep Yadav**

### Abstract

Spinal cord injury (SCI) is a devastating condition often affecting young and healthy individuals around the world. This debilitating condition not only creates enormous physical and emotional cost to individuals but also is a significant financial burden to society at large. It requires multidisciplinary medical and rehabilitation services to rebuild their lives and contemplate the opportunity for an independent and productive future. In this study a 40 years old male of post-surgical Spinal Cord Injury considered for the rehabilitation program. Based on the American Spinal Injury Association (ASIA) Impairment Scale and neurological classification standards, subject had a C6 injury classified as ASIA D. Functional outcome measures Spinal Cord Independence Scale, Berg Balance Scale, Functional Gait Assessment and Trunk Impairment Scale scores are improved after rehabilitation program. This study conclude that rehabilitation programs are very effective and beneficial in the recovery of patients with SCI.

**Keywords:** Spinal cord injury, rehabilitation, recovery, berg balance scale

### Introduction

The incidence as well as the prevalence of spinal injuries has been on the rise with the incidence rate being estimated to be from 15 to 40 cases per million worldwide. The developments in the management of spinal cord injury (SCI) have led to decrease in morbidity and mortality rates, thereby increasing the prevalence of patients with varying degrees of functional limitations [1]. It is estimated that globally in 2007, there would have been between 133 and 226 thousand incident cases of TSCI from accidents and violence. The proportion of TSCI from land transport is decreasing/stable in developed but increasing in developing countries due to trends in transport mode (transition to motorised transport), poor infrastructure and regulatory challenges. TSCIs from low falls in the elderly are increasing in developed countries with ageing populations. In some developing countries low falls, resulting in TSCI occur while carrying heavy loads on the head in young people. In developing countries high-falls feature commonly from trees, balconies, flat roofs and construction sites [2]. TSCI is also due to crush-injuries, diving and violence.

Spinal cord injury (SCI) is a devastating condition often affecting young and healthy individuals around the world. This debilitating condition not only creates enormous physical and emotional cost to individuals but also is a significant financial burden to society at large. It requires multidisciplinary medical and rehabilitation services to rebuild their lives and contemplate the opportunity for an independent and productive future [3].

Edgerton et al suggested that plasticity and motor learning in the spinal cord neural circuitry is dependent, first, on providing the specific sensory input associated with performance of a motor task and, second, on repetitive practice of the task [4]. If the human spinal cord can learn by responding to specific cues related to locomotion, then understanding these mechanisms may lead to new approaches for rehabilitation of gait and functions after neurological injury. The purpose of this case study is to describe that the rehabilitation strategies including conventional rehabilitation and advanced technologies like Pablo® plus system [5] and Body Weight Support Treadmill are very effective in improving the quality of life in spinal cord injury patients.

**Case description**

Patient was a 40 years old male of post-surgical Spinal Cord Injury with chief complain of right side of body weakness along with numbness and heaviness, tingling numbness in left hand and difficulty in daily living since 1999 after surgery. Patient complains right side weakness since 1993 and then after surgery in 1999 the weakness increased and also numbness in left hand. Patient took physiotherapy only for 15 days after surgery but the condition deteriorated. Patient had trauma (due to fall on extended neck) in 1993, since then quadriperesis with right more affected than left. In 1994 went for MRI and diagnosed with SCI (occipitalization of atlas with basilar invagination posterior compression and mild anterior compression) and advised for surgery. Posterior decompression and C2-C4 fusion in June 1999 was done with length of stay 8 days and 2 days on ventilator and then on O<sub>2</sub> therapy. Patient is cooperative and oriented. Initial screening for cognitive deficits was done using MMSE scale with a score 23/30. Based on the American Spinal Injury Association (ASIA) Impairment Scale and neurological classification standards, subject had a C6 injury classified as ASIA D. According to Modified Ashworth Scale spasticity of grade 1 was recorded.

**Functional assessment**

Spinal Cord independence Measure (SCIM) address three specific areas of function in patients with SCI. it looks at self-care, respiration and sphincter management, and patient’s mobility abilities. The maximum attainable score is 100. Its scoring system is self-explanatory [6].

Balance was evaluated by using Berg Balance Scale. The BBS was used to assess balance performance during 14 sitting and standing tasks. Each test items are scored on a scale from 0-4 based on the time or distance requirements, supervision required, need for external support, or need for assistance from the examiner. The highest attainable score of balance function is 56 [7].

Trunk impairment scale (TIS) assesses the static and dynamic sitting balance and trunk coordination in sitting position. It includes static and dynamic sub scales also. The total score of TIS ranges between 0 for a minimal performance to 23 for a perfect performance [8].

Functional Gait Assessment (FGA) Scale is used to assess postural stability during various walking tasks. Total number of items are 10 which are scored on an ordinal scale from 0-3. The score is 30 [9].

**Intervention**

- PNF – Started with Rhythmic initiation and followed by combination of isotonic.
- Unilateral bridging 3 set 10 repetition.
- Stretching (hamstring, adductors, calf, iliopsoas) 10 repetition with 30 seconds hold.
- NDT included sit to stand activities, step up and step down on foot stool, ball kicking backward 10 repetition of each.
- MRP included putting the beads, stacks of glass, pour water into glass, picking up objects of different shapes 3 sets of 10 repetition.
- Gait training included tandom walking, side walking on 7 meter pathway 10 repetition.
- Balance training included Trampoline, Swiss ball, Obstacle crossing, Tandom stand, Supported squats.
- For coordination included Finger to finger, Finger to nose, Heel to shin.
- Advanced technology - Upper limb exercises with Pablo plus system for 20 minutes, this multifunctional, handhold device contains pressure and acceleration sensors which allow measuring vertical, horizontal and rotating limb movements and grip force exertion with the hand [7].

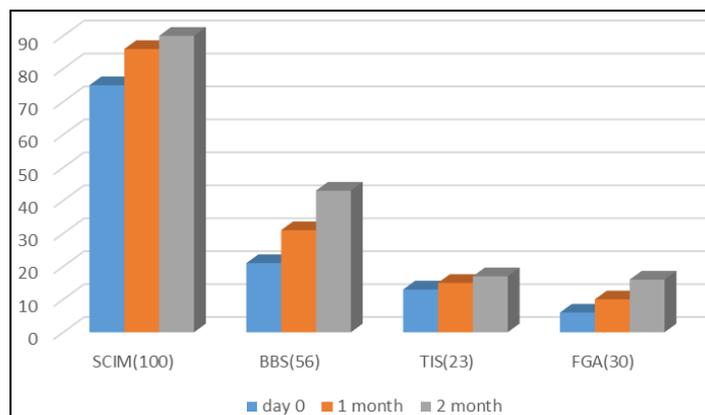
BWST for 15 minutes. It generate stepping speed approximately normal walking speed. Provide the maximum sustainable load on the stance limb. Maintain an upright and extended trunk and head. Avoid weight bearing on the arms and facilitate reciprocal arm swing. Approximate the normal hip, knee, and ankle kinematics for walking [10].

**Result**

The patient improved with all the outcome measure scores after one month and two months rehabilitation program as shown in table.

**Table 1:** Shows improvement in outcome variables with time

Scales/Day	Day 1	After 1 month	After 2 month
Spinal Cord Independent Measure	75/100	86/100	90/100
Berg Balance Scale	21/56	31/56	43/56
Trunk Impairment Scale	13/23	15/23	17/23
Functional Gait Assessment	6/30	10/30	16/30



**Graph 1:** Shows improved scores of functional variables with time.

The graph shows the increasing scores of functional outcome measures. The blue bar shows the score of day 0, orange bar shows improved scores after one month, whereas the grey bar shows the scores after two months.

### Discussion

In this study the patient suffering from chronic spinal cord injury, which leads to secondary impairments and disability. Through this study we emphasised on the exercise protocol to control and prevent the secondary impairments. After rehabilitation program to the spinal cord injury patient reassessment was done on one month and 2 months. The result of the study showed that Spinal Cord Independence Measure improved by 12% after one month whereas 18% after 2 months, Berg Balance Scale score 15% after one month whereas 45% after 2 months, Trunk Impairment Scale score 3% after one month and 5% after 2 months, Functional Gait Assessment 6% after one month and 16% after 2 months. Initially, the BBS score shows that the patient was at medium risk fall but after rehabilitation the score improves and after two months the score obtained shows that the patient was at low risk fall. This study performed balance training based on contents of BBS (Berg balance scale) which is one of the assessment tools. Balance deficiency is main cause of injury by falling in patients. The dominant reasons falling of patient are balance strategically problem by reduced muscle strength, lack of agility, input of inaccurate information, slow determination and reduced proprioceptive ability. To prevent these, long-term regular exercise or activity is required to patient because it improves the ability to maintain dynamic posture<sup>[11]</sup>. Muscle strength and muscle endurance are closely related to the ability of balance and gait. A study on Patients with Cerebellar Ataxia found that balance training based on berg balance scale can improve balance ability in patients with cerebellar ataxia<sup>[12]</sup>.

Functional Gait assessment Scale Score improvement are recorded after conventional as well as BWST training. For BWSTT there are 2 assumption. First, the spinal cord has the ability to respond to appropriate afferent information to generate stepping. Second, activity-dependent plasticity occurs in the neural circuitry responsible for locomotion at both spinal and supraspinal levels<sup>[13]</sup>. Using these principles as the foundation for locomotor rehabilitation hypothesizes that the nervous system adapts to specific activity and that recovery requires relearning the task of walking by providing the spinal cord with the appropriate sensory information. Whereas conventional gait rehabilitation following SCI usually is designed to emphasize facilitation of recovery through strengthening and endurance training of the unaffected muscles. Together, these therapeutic strategies are designed to promote maximum functional capacity of muscles and to compensate for the absence of volitional lower-limb muscle contractions or for weakness and thus improving the gait.

Spinal Cord Independence Measure scores are found to be improved because of improve mobility, tone, strengthening of weakened part, reduction in pain and improvement in concentration. Moreover, patient was cooperative and was performing the exercises well. It is also proven in the study that during the resistance training exercises there is an increase in maximal muscle force output, moreover neural adaptation occurs. Recent evidence also suggests that increased excitation may occur at the cortical levels. Neural adaptation include decreases in motor unit recruitment thresholds, increased motor unit discharge rates, and increases

in double discharges<sup>[14]</sup>.

### Conclusion

The study showed improvement in all the outcome measures. Thus it is concluded that rehabilitation program are very important for management of impaired functions in patients of spinal cord injury and improving their quality of life. Moreover, it has been thought that rehabilitation is only effective in initial stages of recovery of diseases but this study also showed that in chronic cases also rehabilitation can be the one of the effective measures in improving the conditions.

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