

CASE STUDY

IJPHY

EFFECT OF LOCOMOTOR TRAINING WITH BODY WEIGHT SUPPORT ON GAIT AND LOWER LIMB STRENGTH IN INCOMPLETE SPINAL CORD INJURY-A CASE REPORT

¹Parneet Kaur Bedi²Narkeesh Arumugam

ABSTRACT

Background: Irrespective of the severity of the spinal injury, time after lesion and age at time of injury, the restoration of walking is given high priority by subjects with SCI. There is ample amount of literature with gait training methods for restoration of locomotion from other parts of the world. Rehabilitative training is currently one of the most thriving treatments to promote functional recovery following SCI. Many strategies exist to enhance locomotion, such as treadmill training with and without body weight support, robotic-assisted gait training, functional electrical stimulation, epidural stimulation and surface spinal stimulation. Pertaining to developing countries, this case study is an attempt to determine the effect of Locomotor Training with Body Weight Support on Gait and Muscle Strength in Incomplete Spinal Cord Injury.

Method: Single case design, Body weight support treadmill training for over a period of 12 months for an Individual with SCI (ASIA C) in a private clinic set up for SCI rehabilitation. ASIA lower extremity muscle strength, Spinal Cord Injury Functional Ambulation Inventory and Walking Index for Spinal Cord Injury –II.

Results: Significant change in lower extremity muscle strength, gait parameters and temporal parameters of SCI-FAI. Though, no change was observed in score of assistive devices and similarly WISCI-II scoring.

Conclusion: Single participant case study provided us with vital evidence for locomotor training with Body weight support in incomplete SCI. Further research in to the field shall yield valuable clinical findings.

Keywords: Locomotor Training, Body Weight Support Treadmill Training, Incomplete Spinal Cord Injury, Central Pattern Generator.

Received 15th June 2016, revised 23rd July 2016, accepted 04th August 2016



www.ijphy.org

10.15621/ijphy/2016/v3i4/111058

CORRESPONDING AUTHOR

¹Parneet Kaur Bedi

Doctoral Researcher,
Department of Physiotherapy,
Punjabi University Patiala, Punjab

²Professor,
Department of Physiotherapy,
Punjabi University Patiala, Punjab

INTRODUCTION

Independent locomotion, though not fundamental for human survival, is still important in terms of physical and psychological health [1]. A major goal for many patients after SCI is to recover the ability to walk [2]. It is critical that rehabilitation training is designed and implemented to maximize locomotor ability and functional recovery after SCI. Ample research studies over the years suggest body weight-supported treadmill training (BWSTT) as a promising method for improving functional ambulation after spinal cord injury (SCI). Locomotor training with body weight support (LTBWS) has been proposed as an alternative option for the rehabilitation of people with spinal cord injury (SCI), in order to develop at most the body's residual potential and assist in the individual's reintegration into family, professional, and social daily life [3].

Body weight-supported gait training enables patients to walk with a near-normal gait pattern while their weight is relieved. In this procedure a portion of the patient's body weight is supported while the patient is assisted to walk on a motorized treadmill with the goal of providing normal kinematic and temporal cues during walking. BWSTT is based on practicing a normal physiologic gait pattern, with attention to the ideal kinematic and temporal aspects of gait [4].

One of the essential for enhancing locomotor abilities, as identified by early researchers [5] is "The basic or stereotyped movement synergy to achieve propulsion", this can be regarded as the elementary stepping that is generated by the central pattern generator (CPG) for locomotion present in the lumbar spinal cord, and the CPG can be well trained by applying BWSTT."

With intention of retraining the CPG for locomotion, the purpose of this case study was to determine the effectiveness of BWSTT on gait performance and lower limb strength in a patient with incomplete SCI [6].

CASE REPORT

The participant was a young male of 27 years age, with no cognitive deficit. He has completed the initial rehabilitation phase and was suffering from incomplete SCI since 5 years. Participation of human subject was approved by Institutional Ethical Committee (IEC, Punjabi University Patiala, Punjab) before the initiation of the study. Patient was explained in detail about the purpose and methods of this study. Informed consent was obtained from the participant.

The participant underwent basic examination; ASIA grading, Walking Index for Spinal Cord Injury –II (WISCI-II), Spinal Cord Injury-Functional Ambulatory Inventory (SCI-FAI) and Modified Ashworth Scale (MAS) as baseline assessment. Patient had flaccidity in crural group of muscle of both lower limbs. In rest of the muscles of the left lower limb and right limb there was no increase in muscle tone according to Modified Ashworth Scale.

The participant received 40 minutes, thrice weekly session

of BWSTT. 140 sessions of BWSTT were delivered to the participant in a period of 12 months.

Decisions about the amount weight to be suspended from the suspension frame were made by examining the gait pattern. Initially, fifty percent of individuals' body weight was added in the suspension system and adjusted accordingly with improvements. It was made sure that the weight used should neither cause heel off nor knee flexion on the loading leg during stance phase of the gait training [5].

Along with the BWSTT, the participant received sessions of Activity Based Therapy [7] for Strength, Endurance and functional training.

RESULTS

The present study used two outcome measures (WISCI-II and SCI-FAI) for assessing the ambulatory function in patient with incomplete SCI and ASIA motor score for lower limb. Outcomes were measured at baseline and at the end of 12 months of interventions.

The walking index for spinal cord injury (WISCI-II) [8,9] is an ordinal scale. It determines the limitations in ambulation, type of gait pattern (Swing to/swing through) in a patient with SCI and requirement for the use of braces and assistive devices for walking (ambulation).

The scores are called levels and range from 0 to 20. Second outcome measure; Spinal Cord Injury Functional Ambulation Inventory (SCI- FAI) [12] is an observational gait assessment that includes 3 key domains of walking functions. The subscales include; gait parameters, assistive devices and temporal parameters. Higher scores denote higher levels of function in each subscale.

Thirdly, lower extremity motor score (ASIA motor score) was used to assess the strength of five key lower limb muscles using manual muscle testing [10,11]. Scores ranged from 0 to 50. In all the three outcome measures the higher values indicate better performance.

The following section depicts the changes in locomotor functional ability and muscle strength across the 140 sessions of BWSTT.

Table 1: Changes observed in scores of ASIA LEMS, WISCI-II and SCI-FAI across 140 sessions of BWSTT

Time Frame	ASIA SCORES		WISCI II SCORE (20)	SCI-FAI		
	(R) LEMS (25)	(L) LEMS (25)		Gait Parameters (20)	Assistive devices (14)	Temporal Parameters (5)
June 2015	8	7	15	11	11	5
May 2016	11	11	15	18	11	5

Table 2: Two Minutes Walk Test (SCI-FAI) across 140 sessions of BWSTT

Time Frame	Two minutes walk test
June 2015	57 feet
May 2016	220 feet

DISCUSSION

The present work is discrete in its implementation of a gait training strategy for patient with incomplete paraplegia using the method of body weight-supported treadmill training regimen for a period of 12 months and determining the effect on gait performance and lower limb strength.

It was observed that there were significant change in lower extremity muscle strength, gait parameters and temporal parameters of SCI-FAI. Though, no change was observed in score of assistive devices and similarly WISCI-II scoring. These results have been found to be analogous to a number of other studies that have reported improvements in lower limb strength and gait for participants with both chronic [12-16] and sub-acute spinal cord injury [17-18] following body weight-support training.

The theoretical underpinning for developing locomotor training for individuals with SCI comes from research works which studied the recovery of locomotion in cats with SCI [19,20]. A viable neuro-physiological description for these motor responses may be that the continuous movement of the treadmill and the repetition of steps could stimulate neural circuits of locomotion control, which makes up the so-called central pattern generator (CPG) at the spinal level [21,22].

CPG is responsible for producing the rhythmic, cyclic gait pattern, even after SCI, as it is present in the spinal cord [23,24]. CPG activation during training on the treadmill could favour the neural plasticity processes by regulating the interaction between CPG and peripheral reflex activity. Training stimulates neuronal activity and it produces a better activation of the spinal centres of locomotion control. Thus, synaptic and cell responses of the control circuits CPG may be more flexible or more appropriately modulated on the treadmill than on the floor [25].

LTBWS in patients with incomplete SCI may be an important ally in motor rehabilitation, especially through neural plasticity[26] something which allows learning a new gait pattern. This learning depends on specific sensory inputs associated to the fulfilment of a motor task and the repetitive practice of this task [27].

CONCLUSION

Single participant case study provided us with vital evidence for locomotor training in incomplete SCI, a larger trial shall suffice the quality of evidence. Through this cases study it has been concluded that the BWSTT improved the gait with substantial increase in lower extremity muscle strength, gait parameters and temporal parameters. The walking speed improved from 0.144m/

sec to 0.55m/sec. The participant became an independent community ambulatory at a speed at least 50% of normal. This evidence will be crucial in designing better regimen, both in terms of content and context, of the rehabilitation process after SCI.

REFERENCES

- [1] Noreau LP, Proulx PMD, Gagnon LM, Drolet MM, Laramee M. Secondary impairments after spinal cord injury: a population-based study. *Am J Phys Med Rehabil.* 2000 Nov-Dec;79(6):526-35.
- [2] Aubrey A.W, Sybil N. J and Fowler D. Spinal Cord Injury: A synopsis of the basic science. *Can Vet J.* (2010). 51:485–492.Cited from: Bedi.P.K and Arumugam N.Activity based therapy and Surface Spinal Stimulation for recovery of walking in individual with traumatic Incomplete Spinal Cord Injury: a case report. *International Journal of Recent Scientific Research.* 2015;6 (8):5581-5583.
- [3] Cristina M.R.D, Cynthia M.R.D, Auristela D de L.M, Elisangela F. M. Locomotor training with partial body weight support in spinal cord injury rehabilitation: literature review. *Fisioter. Mov.*2013;26 (4): 907-920.
- [4] Lovely RG, Gregor RJ, Roy RR and Edgerton VR. Effects of training on the recovery of fullweight-bearing stepping in the adult spinal cat. *Exp Neurol.* 1986 May;92(2):421-35.
- [5] Grillner S, Wallen P. Central pattern generators for locomotion, with special reference to vertebrates. *Annu Rev Neurosci.* (1985).8:233–261.
- [6] Harkema.S, Behrman.A and Barbeau.H. Locomotor Training:Principles and Practice.(2011).Oxford University Press.NY.
- [7] Bedi.P.K and Arumugam N. Activity based therapy and Surface Spinal Stimulation for recovery of walking in individual with traumatic Incomplete Spinal Cord Injury: a case report. *International Journal of Recent Scientific Research.* 2015); 6 (8):5581-5583.
- [8] Ditunno JF Jr, Ditunno PL, Graziani V, Scivoletto G, Bernardi M, Castellano V, et al. Walking index for spinal cord injury (WISCI): an international multicenter validity and reliability study. *Spinal Cord.* 2000 Apr;38(4):234-43.
- [9] Dittuno PL and Ditunno JF. Walking index for spinal cord injury (WISCI II): scale ision. *Spinal Cord.* 2001 Dec;39(12):654-6.
- [10] Marino RJ and Graves DE. Metric properties of the ASIA motor score: subscales improve correlation with functional activities. *Arch Phys Med Rehabil.*2004; 85(11): 1804–1810.
- [11] Maynard FM Jr, Bracken MB, Creasey G, Ditunno JF Jr, Donovan WH, Ducker TB, et al. International standards for neurological and functional classification of spinal cord injury. American Spinal Injury Association. *Spinal Cord.* 1997; 35(5):266–274.
- [12] Field-Fote EC, FluetGG, Schafer SD, Schneider EM, Smith R, Downey PA, Ruhl CD. The spinal cord injury functional ambulation inventory (SCI-FAI).

- Journal of Rehabilitation Medicine*. 2000; 33(4): 177-181.
- [13] Behrman AL and Harkema SJ. Locomotor training after human spinal cord injury: a series of case studies. *Phys Ther*.2000; 80(7): 688–700.
- [14] Field-Fote EC. Combined use of body weight support, functional electric stimulation, and treadmill training to improve walking ability in individuals with chronic incomplete spinal cord injury. *Arch Phys Med Rehabil*. 2001; 82(6):818–824.
- [15] Thomas SL and Gorassini MA. Increases in corticospinal tract function by treadmill training after incomplete spinal cord injury. *J Neurophysiol*. 2005; 94(4):2844–2855.
- [16] Dietz V, Wirz M, Colombo G and Curt A. Locomotor capacity and recovery of spinal cord function in paraplegic patients: a clinical and electrophysiological evaluation. *Electroencephalogr Clin Neurophysiol* 1998; 109(2): 140–153.
- [17] Hicks AL, Adams MM, Martin Ginis K, Giangregorio L, Latimer A, Phillips SM, et al. Long-term body-weight-supported treadmill training and subsequent follow-up in persons with chronic SCI: effects on functional walking ability and measures of subjective well-being. *Spinal Cord*. 2005; 43(5):291–298.
- [18] Alexeeva N, Sames C, Jacobs PL, Hobday L, Distasio MM, Mitchell SA, et al. Comparison of training methods to improve walking in persons with chronic spinal cord injury: a randomized clinical trial. *J Spinal Cord Med*. 2011;34(4): 362–379.
- [19] Barbeau, H. Locomotor training in neurorehabilitation: emerging rehabilitation concepts. *Neurorehabil Neural Repair*. 2003;17(1):3-11.
- [20] Threlkeld AJ, Cooper LD, Monger BP, Craven AN, Haupt HG. Temporospacial and kinematic gait alterations during treadmill walking with body weight suspension. *Gait Posture*. 2003;17(3):235-45.
- [21] Dietz V, Harkema SJ. Locomotor activity in spinal cord-injured persons. *J Appl Physiol* .1985;96(5):1954-60.
- [22] Capaday, C. The special nature of human walking and its neural control. *Trends Neurosci*. 2002 Jul;25(7):370-6.
- [23] Miyai I, Fujimoto Y, Ueda Y, Yamamoto H, Nozaki S and Saito T. Treadmill training with body weight support: Its effect on Parkinson's disease. *Arch Phys Med Rehabil*. 2000;81(7):849-52.
- [24] Rossignol S, Schwab M., Schwartz M, Fehlings MG. Spinal cord injury: time to move? *J Neurosci*. 2007;27(44):11782-92.
- [25] Mackay-lyons M. Central pattern generation of locomotion: a review of the evidence. *Phys Ther*. 2002;82(1):69-83.
- [26] Jakeman LB, Hoschouer EL, Basso DM. Injured mice at the gym: review, results and considerations for combining chondroitinase and locomotor exercise to enhance recovery after spinal cord injury. *Brain Res Bull*. 2011;84(4-5):317-26.
- [27] Edgerton VR, Leon, RD, Harkema SJ, Hodgson JA, London N, Reinkensmeyer DJ, et al. Retraining the injured spinal cord. *J Physiol*. 2001;533(Pt 1):15-22.

Citation

Bedi, P. K., & Arumugam, N. (2016). EFFECT OF LOCOMOTOR TRAINING WITH BODY WEIGHT SUPPORT ON GAIT AND LOWER LIMB STRENGTH IN INCOMPLETE SPINAL CORD INJURY-A CASE REPORT. *International Journal of Physiotherapy*, 3(4), 478-481.