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Case Report

Feasibility of Body Weight Support Treadmill Training for Addressing Activity Limitation in Higher Thoracic Complete Spinal Cord Injury-A Case Report

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Abstract

Background: Spinal Cord Injury (SCI) is a devastating condition, caused by both traumatic and non-traumatic incidence. Achieving independent ambulation is commonly reported by the patients as their primary goal in SCI rehabilitation. Body Weight Support Treadmill Training (BWSTT) allows patient to perform task-specific gait training without overcompensating with the available motor function. Case reports on ASIA A SCI for identifying the effectiveness of BWSTT is scarce.

Case Presentation: This case report describes about a ten year old boy with a diagnosis of diagnosis of T4 ASIA-A complete paraplegia. After the surgical management of higher thoracic atrio-venous malformation, the patient requested the need for improving his therapeutic walking endurance in overcoming the activity limitation. After 90 sessions of BWSTT in four months, the six-minute walk distance recorded 66meters with minimal exertion, compared to 17meters he could achieve prior to training in BWSTT.

Conclusion: The BWSTT is a feasible alternative for over-ground gait training in complete SCI in view of providing task-specific functional training to improve ambulation and motivation for rehabilitation.

Keywords: Body Weight Support Treadmill Training; Spinal Cord Injury; Activity Limitation

Abbreviations

ADL: Activities of Daily Living; ASIA: American Spinal Injury Association; AVM: Atrio-Venous Malformation; BWSTT: Body Weight Support Treadmill Training; CPG: Central Pattern Generator; FIM: Functional Independence Measure; KAFO: Knee Ankle Foot Orthosis; ROM: Range of Motion; SCI: Spinal Cord Injury; SCIM: Spinal Cord Independence Measure

Background

Spinal Cord Injury (SCI) is a devastating condition, caused by both traumatic and non-traumatic incidence. The worldwide incidence of spinal cord injury is between 40 to 80 cases per million population [1]. Atrio-Venous Malformation (AVM) of the spine can lead to signs and symptoms similar to SCI.

Achieving independent ambulation is commonly reported by the patients as their primary goal in SCI rehabilitation. The restriction in walking and activity limitation pertaining to ambulation greatly hamper their performance in activities of daily living, as well as the motivation for further rehabilitation. Body Weight Support Treadmill Training (BWSTT) allows patient to perform task-specific gait training without overcompensating with the available motor function [2]. Studies have reported equivalent effect of BWSTT and conventional rehabilitation in improving gait functions of patients with incomplete SCI [3,4].

Evidence on the effectiveness of BWSTT focus majorly on those patients belong to ASIA scale C and D. Patients with ASIA A and B SCI have reported to recover walking in only 10 to 15% of the cases

[5]. Case reports on ASIA A SCI for identifying the effectiveness of BWSTT is scarce. This report address the feasibility of BWSTT in addressing the functional limitation of a patient with higher thoracic complete SCI.

Case Presentation

A ten year old boy was presented to the neurosurgery OPD of our institution with complaints of pain in the upper back with shooting radiating pain to the chest for past one month, and was medically managed since then. He also had urinary retention, which was managed with catheterisation. The MRI scans reported intramedullary AVM of small nidus at D5 with supply from anterior spinal artery. He underwent D2-D9 laminotomy and excision of AV fistula at D4-D5 level and laminoplasty on 20/10/2022. Once the patient was stable at recovery, he was then admitted for rehabilitation at the same institute on 29/10/2022.

The initial physiotherapy assessment on the first day of admission revealed complete passive range of motion of both upper and lower limbs, with 5/5 power in the upper limbs and 0/5 power of lower limbs. Sensory evaluation identified absent pin prick and light touch sensation below T4 level bilaterally. The Spinal Cord Independence Measure (SCIM) score on the first day of assessment was 16/100, Functional Independence Measure (FIM) was 62/126, and the Barthel Index score was 15/100. He was bed bound and was unable to ambulate with any assistive devices on the first day. The conventional rehabilitation protocols were initiated with a provisional diagnosis of T4 ASIA-A complete paraplegia.

Physiotherapy management focussed on maintaining range of motion of limbs, sitting balance training, and gradual progression of standing with assistive devices. The in-patient training was continued for about two months. During this period, the patient learned ambulation with bilateral Knee Ankle Foot Orthosis (KAFO) and standard walker with compensatory patterns of upper trunk and upper limb. The six-minute walk test on the day of discharge (07/01/2023) recorded a distance of 17 meters and a Borg exertion of 5/10.

The patient was then treated in the out-patient settings of physiotherapy center for the next four months. The treatment goals were set with the discussion of patient and caregiver. The chief concern of the boy was to improve his walking ability with the walker so as to move around at home with minimal assistance. In order to address his activity limitation, Body Weight Support Treadmill Training (BWSTT) was initiated with bilateral KAFO (Figure 1).

The initial BWSTT was prescribed for 20 minutes per day for six days a week. The speed of treadmill was set at 0.3m/s for the first

Figure 1: Body Weight Support Treadmill Training with KAFO.

sessions, with 60% of the weight offloaded. The duration of BWSTT training, speed, and offloaded weight were adjusted every two weeks according to the performance and comfort of the patient. At the end of four months of training (90 sessions), he achieved BWSTT dosage 25% offloading and 1.2m/s treadmill speed. Table 1 summarises the changes in assessment and outcome measures at the beginning of in-patient treatment, at discharge, and after four months of out-patient physiotherapy sessions.

Although the intense training on BWSTT did not demonstrate changes in the neurological symptoms, significant improvements were observed in the dependency level of patients for ADL activities. The six-minute walk test on 31/05/2023 recorded a distance of 66m with a Borg exertion of 3/10, demonstrating an improvement in ambulatory status. The patient also reported subjective improvements in the capacity in performing activities, which were previously difficult.

Outcome Measures		29/10/2022	07/01/2023	31/05/2023
Passive ROM	Upper limbs	WNL	WNL	WNL
	Lower limbs	WNL	WNL	WNL
Muscle Tone (MAS)	Upper limbs	0/4	0/4	0/4
	Lower limbs	1/4	2/4	1/4
Muscle Power (MMT)	Upper limbs	5/5	5/5	5/5
	Lower limbs	0/5	0/5	0/5
Reflexes	Biceps	++	++	++
	Triceps	++	++	++
	Knee	+++	+++	+++
	Ankle	+++	++++	+++
Sensation	Light touch	C2-T4=2 T5-S5=0	C2-T4=2 T5-S5=0	C2-T4=2 T5-S5=0
	Pin Prick	C2-T4=2 T5-S5=0	C2-T4=2 T5-S5=0	C2-T4=2 T5-S5=0
Spinal Cord Independence Measure		16/100	29/100	67/100
Functional Independence Measure		62/126	71/126	92/126
Barthel Index		15/100	35/100	55/100
Six Minute Walk Test	Distance	-	17m	66m
	Borg RPE	-	Pre:1; Post:5	Pre:0.5 Post:3
	Heart Rate	-	Pre:88; Post:130	Pre:84; Post:121
	O_2 Saturation	-	Pre:98; Post:96	Pre:97 Post:97

Table 1: Changes in assessment and outcome measures at three timeframes.

ROM: Range of Motion; WNL: Within Normal Limits; MAS: Modified Ashworth Scale; MMT: Manual Muscle Testing Grading; RPE: Rate of Perceived Exertion

Discussion

Therapeutic goals should be planned in accordance with the 'International Classification of Function', in patients with SCI. The activity limitation identified by the patients must be addressed while setting goal and must be incorporated in the rehabilitation programme. With intense training on BWSTT for four months, there was an improvement in the ambulatory function of the patient as displayed by his performance in six-minute walk test. Significant improvements were also noted in the independence and functional level of the patient assessed using SCIM, FIM and Barthel Index scales. The patient also reported improvements in his mood, and also reported boost in his motivation levels with better walking ability.

Various hypotheses support the improvements in ambulatory status of the patient with BWSTT. Treatment of high intensity and longer durations are reported to facilitate reorganisation of central nervous system and motor learning [6]. Wernig [7] commented that the BWSTT may have explored the capability of motor learning by the isolated spinal cord as the laboratory tests of spinal cats, explaining the existence of Central Pattern Generators (CPG). CPGs are considered to be responsible for producing cyclic movements of the lower limbs without the influence of higher centers [8].

Studies have also reported improvements in psychological status with BWSTT in SCI. Martin., *et al.* [9] found reduction in pain and improvement in feeling states with single-bout of BWSTT in ASIA B and C SCI patients. However, the authors have failed to explain mechanism by which improvements are displayed. We consider the improvement in functional status, which patient once considered that he won't be able to achieve, may have improved his mood and motivation.

Adams., *et al.* [10] in their study could demonstrate improvements in mean fibre area and type I fibre percentage distribution, suggested the role of loading and neural activity with BWSTT and exercise induced changes in muscle properties in bringing up changes in the participants. Studies also reported changes in

cardiac autonomic function, heart rate adaptation, and pulmonary function with BWSTT in patients with ASIA C and D SCI [11]. In their other study, Adams., *et al*. [12] could report reduction in spasticity with BWSTT, which was also reflected in the functional performance of the patient, which was not seen with intra-thecal pharmacological treatment of spasticity. We could also identify reduction in spasticity and muscle tone with four-months of intervention, especially at ankle. The weight bearing achieved with body weight support, and the reciprocal movement of the limbs may have influenced the reduction in spasticity.

The systematic review by Wessels., *et al*. [2] reported superior effect of over-ground training than BWSTT in achieving higher levels of independent walking in patients with incomplete SCI. They also found BWSTT to have significant improvements in those with ASIA C or D (mean difference = 0.80; 95%CI: 0.04-1.53) than those classified as ASIA A or B. We could report improvements in the patient who was classified as ASIA A, suggesting BWSTT not to be restricted for ASIA C and D alone.

Conclusion

The beneficial effects of BWSTT is not justified yet with sufficient scientific evidences [4]. There is no evidence available which support the use of BWSTT in ASIA A SCI patients. The neuro-rehabilitation approaches in patients with SCI should strive to optimize the utilisation of task-specific sensory cues so as to facilitate locomotor patterns of arm and leg, influencing the recruitment of spared spinal and supraspinal circuits for ambulation [13]. Hence, this case report support the use of BWSTT in complete SCI in view of providing task-specific functional training to improve ambulation and motivation for rehabilitation.

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