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CASE REPORT

An outpatient low-intensity locomotor training programme for paediatric chronic incomplete spinal cord injury

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Study design: Single case study.
Objectives: Intensive locomotor training programmes have recently been implemented in paediatric settings for patients with chronic incomplete spinal cord injury. This case study examines whether a lower-intensity locomotor training programme can improve functional ambulation.
Setting: Tertiary care setting in Melbourne, Australia.
Methods: A pretest–post-test design was used for a 17-year-old boy, 16 months after incomplete spinal injury at T6, who was classified as American Spinal Injury Association (ASIA) level C. He participated in two weekly sessions of locomotor training for a period of 6 weeks. Lower Extremity Motor Score (LEMS), Walking Index for Spinal Cord Injury (WISCI II), 6-min walk test (6MWT), 10-m walk test (10MWT), Timed Up and Go (TUG), and the PedsQL were measured before training, immediately after training and 6 weeks after training had ceased.
Results: The WISCI II score improved from 6 at baseline to 9 immediately post treatment and this was maintained at follow-up. The PedsQL score was also significantly improved immediately post treatment and at 6 weeks follow-up. The LEMS and 6MWT improved after the intervention also.
Conclusion: This case study provides evidence of improvements following a less-intensive locomotor training programme in an outpatient setting. Studies with larger samples are required to fully examine the benefits of this programme.
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Keywords: spinal cord injury; locomotor training; treadmill training; functional ambulation

INTRODUCTION

Spinal cord injury (SCI) in children can lead to significant limitations in functional ability and independence. It was previously thought that the nervous system is irreparable after SCI; however, there is emerging evidence from basic science that the central nervous system is malleable and capable of learning.[1] Locomotor training using a treadmill and harness to provide partial body weight support is a relatively new treatment approach that aims to promote the recovery of walking after incomplete SCI. It is thought that an intensive walking programme designed to provide sensory input to the spinal cord to maximise neural output from central pattern generators within the spinal cord will enhance the firing of spinal neuronal centres.[2] The training is labour and time intensive, and there is limited evidence in paediatric SCI. A systematic review of locomotor training in adult SCI found that the evidence is mostly restricted to case reports and cohort studies with further research required.[3] In paediatric SCI, one case study showed improvements in a 5-year-old girl with incomplete SCI at C4 after a 5-month programme; however, this was performed during the acute recovery stage with concurrent inpatient rehabilitation.[4] Another case study of a 4-year-old boy with incomplete cervical SCI who received a 16-week programme of both treadmill and overground training at 16 months after injury showed a return to walking using a walker.[5]

For many paediatric rehabilitation settings it is not feasible or economical to provide daily locomotor training. The purpose of this case study was to investigate whether a less-intensive programme for chronic incomplete SCI in an outpatient setting would provide functional improvements.

MATERIALS AND METHODS

Participant

A 15-year-old boy with a past history of neurofibromatosis type 1, with no previous limitations in his functional and ambulatory abilities, suffered an incomplete SCI at T6 as a result of complications from scoliosis surgery. At 16 months post injury (age 17 years), before locomotor training, he was categorised as American Spinal Injury Association (ASIA) Impairment Scale (AIS) grade C.[6] He could use a walker for 10 m indoors, but required assistance to stand up, walk and sit down. He weighed 58.8 kg and was 154 cm tall. Informed consent was gained for this case study.

Outcome measures

Assessment occurred just prior to locomotor training, 2 days after training ceased and 6 weeks after training had ceased. Outcome measures included the Lower Extremity Motor score (LEMS) of the ASIA Classification, the Walking Index for Spinal Cord Injury (WISCI II), the 10-m walk test (10MWT), 6-min walk test (6MWT) and Timed Up and Go (TUG). The PedsQL 4.0 was also given to the participant and mother to determine physical, emotional, social and school functioning.

The ASIA classification is internationally recognised and reliable, and has sensory and motor scores that together determine a sensory, motor, neurological level and completeness of the injury.[6] The LEMS is one

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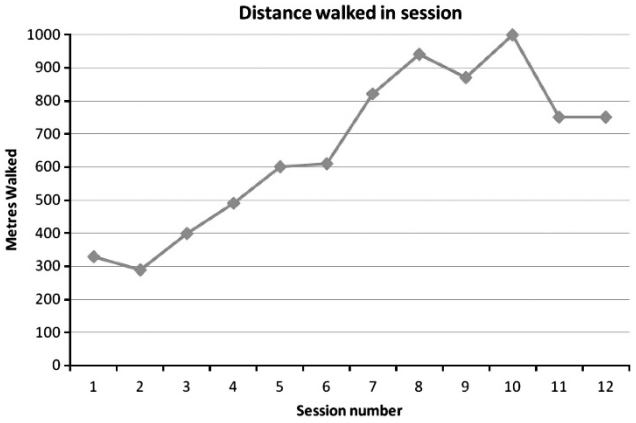

Figure 1 Distance walked on treadmill during treatment sessions.

component of the ASIA assessment encompassing the motor scores from the lower extremities bilaterally scored by the manual muscle test guidelines.[7] It is used often to report recovery in SCI and predict potential for mobility.[8]

The WISCI II scale is a 20-item scale that measures the amount of physical assistance, braces or devices required to walk 10 m.[9] The 10MWT, 6MWT and TUG are all timed tests measuring various aspects of speed, endurance and transfer ability. There are moderate to good correlations of the three tests with the WISCI II, and this indicates that the tests can be used in both clinical practice and research to assess walking function in patients with SCI.[10]

Intervention

The participant received twice-weekly outpatient training over a period of 6 weeks. These 60-min sessions consisted predominately of treadmill training with 20–60 m of over-ground walking with a walking frame at the end. He started with 20 min total walking time in session 1, which increased incrementally over the training period to 33 min in the final session. One physiotherapist and one assistant conducted the intervention and facilitated the gait pattern at each leg. Body-weight support using a harness was at a level where the participant could achieve full knee extension with use of his upper limbs on the handlebars without therapist assistance. For this boy that equated to ~50% of his body weight. The walking speed began at 15 m per min and increased steadily over the 12 sessions to 23 m per min. The participant wore solid ankle foot orthoses (AFOs) to replicate clinical conditions. He did not receive any concurrent physiotherapy during the intervention period.

RESULTS

The participant's speed on the treadmill and distance walked increased over the intervention period (Figure 1). Table 1 displays the results of the outcomes measured at each time point.

Improvements were seen in the WISCI II with change from walking for 10 m with minimal assistance with a walker to ambulating 10 m independently with a walker. He was also able to sit to stand independently after training. The LEMS, 6MWT, TUG and 10MWT were all slightly improved. The PedsQL participant report improved particularly for emotional state and sports activity. The PedsQL parent report remained essentially unchanged.

DISCUSSION AND CONCLUSIONS

This case demonstrates that there are some benefits to a less-intensive locomotor training programme based on clinically feasible conditions. A dosage of two sessions a week for 6 weeks predominantly improved walking independence and quality of life in a 17-year-old boy with a chronic incomplete SCI. Smaller changes were seen in the 6MWT, 10MWT, TUG and LEMS; however, these results could also reflect measurement error. He also improved from requiring help to transfer from sitting to standing to being able to achieve this independently. This translated to improved levels of independence and quality of life in his everyday life. The participant's quality of life as measured by the PedsQL improved significantly in the 6 weeks. Of note, the response to the question 'Is it hard for you to do sports activity or exercise?' went from an 'often difficult' at baseline to an 'almost never' post training.

This case study shows promising results but cannot be generalised to all children with chronic incomplete SCI. Further investigation of the benefits of such a programme in studies with a control group and larger sample sizes including a measure of fitness may determine the benefits that could be made available to the wider paediatric spinal cord injury population.

Table 1 Results of outcomes measured at each time point

	Pre-training	*Post-training*	*Follow-up*
WISCI II	6	9	9
LEMS	16	17	18
6MWT (m)	67, 1 rest	76, no rests	80, no rests
10MWT (s)	32.2	30.3	33.6
TUG (s)	44.6	40.1	42.0
PedsQL participant report			
Total score	38/92	23/92	23/92
Physical functioning	19/32	12/32	12/32
Emotional functioning	5/20	0/20	0/20
Social functioning	6/20	4/20	3/20
School functioning	8/20	7/20	8/20
PedsQL parent report total score	44/92	40/92	35/92

Abbreviations: LEMS, lower extremity muscle score; TUG, Timed Up and Go test; WISCI II, Walking index for spinal cord injury; 6MWT, 6-min walk test; 10MWT, 10-m walk test.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

1 Behrman AL, Bowden MG, Nair PM. Neuroplasticity after spinal cord injury and training: an emerging paradigm shift in rehabilitation and walking recovery. *Phys Ther* 2006; **86:** 1406–1425.
2 Edgerton VR, Tillakaratne NJK, Bigbee AJ, de Leon RD, Roy RR. Plasticity of the spinal neural circuitry after injury. *Ann Rev Neurosci* 2004; **27:** 145–167.
3 Mehrholz J, Kugler J, Pohl M. Locomotor training for walking after spinal cord injury. *Spine* 2008; **33:** E768–E777.
4 Prosser LA. Locomotor training within an inpatient rehabilitation program after pediatric incomplete spinal cord injury. *Phys Ther* 2007; **87:** 1224–1232.
5 Behrman AL, Nair PM, Bowden MG, Dauser RC, Herget BR, Martin JB *et al.* Locomotor training restores walking in a nonambulatory child with chronic, severe, incomplete cervical spinal cord injury. *Phys Ther* 2008; **88:** 580–590.
6 Kirshblum SC, Burns SP, Biering-Sorensen F, Donovan W, Graves DE, Jha A *et al.* International standards for neurological classification of spinal cord injury (revised 2011). *J Spinal Cord Med* 2011; **34:** 535–546.
7 Herbison GJ, Isaac Z, Cohen ME, Ditunno JF Jr. Strength post-spinal cord injury: myometer vs manual muscle test. *Spinal Cord* 1996; **34:** 543–548.
8 Burns AS, Ditunno JF. Establishing prognosis and maximizing functional outcomes after spinal cord injury: a review of current and future directions in rehabilitation management. *Spine* 2001; **26** (24 Suppl): S137–S145.
9 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; **38:** 234–243.
10 van Hedel HJ, Wirz M, Dietz V. Assessing walking ability in subjects with spinal cord injury: validity and reliability of 3 walking tests. *Arch Phys Med Rehabil* 2005; **86:** 190–196.