Practical issues in retraining walking in severely disabled patients using treadmill and harness support systems

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Introduction

In the last decade, a novel form of gait training using a treadmill and partial body weight support through an overhead harness has been described for patients with neurological impairments caused by stroke and spinal cord injury (for review see Barbeau et al 1998). The overhead harness attached over a treadmill decreases postural demands and supports part of the body weight, which allows the individual to walk without collapse of the affected lower limb or limbs. One of the barriers to completion of walking practice by severely disabled patients is that marked muscle weakness and poor co-ordination results in an inability to practice the whole task without considerable assistance. Patients often require the assistance of two or more people to stand and take a few steps. The benefit of treadmill walking with body weight support via an overhead harness for these patients is that it provides the opportunity to complete larger amounts of practice of the whole task, early after neurological impairment.

There have been several studies illustrating that using a harness to provide partial body weight support while walking on a treadmill improves the pattern of walking after stroke (Hesse et al 1997 and 1999). While there is as yet no definitive answer on whether this intervention improves the outcome of walking, there are several studies that suggest that this may be the case. For example, Hesse and colleagues (1994), in a multiple baseline study, reported that seven of nine chronic, non-ambulatory stroke patients were able to walk after three weeks of treadmill training. Wernig and colleagues (1995) noted that 76% of chronic incomplete spinal cord injured patients learned to walk independently after 10 weeks of treadmill training compared with 7% in the control group. The provision of weight support seems crucial since Visintin et al (1998), in a randomised controlled trial, found a small beneficial effect when treadmill training was combined with partial weight support, compared with no weight support.

Recently, a number of different body weight support treadmill training systems have become available commercially in Europe and North America. During 1998–99, researchers and clinicians at The University of Sydney and The Prince Henry Hospital in Sydney trialled three different treadmill and harness systems on patients with neurological impairments. The three devices, TR Spacetrainer(a), Lite-Gait(b) and Z-Lift(c) were provided on loan to the hospital by their Australian suppliers. Based on our experiences, we present some practical guidelines on using treadmill training during everyday clinical practice, and report on the advantages and disadvantages of these systems.

Feasibility of treadmill training in clinical practice

There are three key elements to the procedure for using treadmill training with an overhead harness to help retrain walking: fitting the harness, determining the amount of weight support and selecting the speed of the treadmill. First, the harness needs to be fitted to the patient. If this can be done in sitting and the system has an automatic lifting ability, only one therapist is needed to prepare the patient to take steps. However, if the harness has to be fitted in standing or the system does not have an automatic lifter, up to three therapists may be required for this part of the procedure. The next step is to determine the appropriate amount of body weight support. This clinical decision is based on observation of the patient’s ability to maintain hip and knee extension while loading the leg. Hesse et al (1997) have shown that ≤30% body weight support results in the most normal gait pattern. However, very weak patients may need more body weight support and therefore the range is typically between 0-50%. Any more than 50% body weight support will result in the patient walking on their toes. As strength in the lower limb muscles improves, the amount of support from the harness is reduced. Another clinical decision is selecting the speed of the treadmill. The aim is to run the treadmill as fast as possible while still maintaining an adequate step length. If, for example, an increase in speed results in an increase in cadence but a reduction in step length, then the speed is reduced. Another factor influencing the choice of speed is the patient’s ability to swing the leg through. For example, a very weak hemiplegic stroke patient will need assistance from a therapist to lift the affected leg through during the swing phase, whereas spinal cord injured patients may need two therapists to assist (Figure 1).

The presence of an automatic lifter means that patients can have frequent rests during walking without having to undo the harness. A very disabled patient who might need the
assistance of three therapists to walk over-ground, will “walk” 60 metres (which may translate to more than 150 steps) even if they only walk for five minutes at a slow speed of 0.2m/s. Therefore, walking on the treadmill can provide more practice than over-ground walking with considerably less effort from the therapists.

The following case studies illustrate these clinical decisions in an individual after stroke and another who had suffered a spinal cord injury.

Case studies

Sixteen days following stroke, GM could not stand alone or walk. He needed two therapists to help him take a few steps and was therefore severely disabled. Every weekday, following exercises designed to strengthen and improve skill in his lower limb extensors (Carr and Shepherd 1998), he walked on the treadmill with some of his weight supported by a harness. He began by walking 30 metres at 0.3m/s with 50% of his weight supported by a harness while the therapist lifted his affected right leg through. One week later, he was walking 70 metres with only 35% of his weight supported. He was able to swing his leg through himself but needed help from the therapist to prevent his knee from hyperextending during stance phase. A week later he was walking 100 metres at 0.6m/s with only 20% of his weight supported, but could not stop his knee from hyperextending. The treadmill parameters were therefore kept constant over the next two weeks while he concentrated on learning to control his knee. Five weeks after he began, he walked 330 metres at 0.9m/s with no support from a harness and his walking practice was continued over-ground. On discharge from rehabilitation, seven weeks later and 15 weeks after his stroke, he was walking at 1.6m/s and could walk 430 metres in six minutes, a near normal performance.

Eight months following an incomplete C4 spinal cord injury, IM needed two therapists to help him stand and take two or three steps. He had severe spasm in his trunk and lower limbs. He began treadmill walking at 0.5m/s with 40% of his weight supported while two therapists helped lift his legs through. His extensor spasm seemed less of a problem on the treadmill. Over the following four weeks, IM increased his speed to 0.6m/s with 30% support and walked 180 metres. He then started walking over-ground with a forearm support frame. He needed help from one therapist to get into standing but could walk with supervision only. At discharge, four weeks later and 10 months after injury, he could manoeuvre the frame around obstacles and his walking speed was 0.4m/s.

Advantages and disadvantages of the TR Spacetrainer, Lite-Gait and Z-Lift

The TR Spacetrainer incorporates a treadmill with overhead harness and body weight support system in one composite unit. It has an access ramp so that a wheelchair can be wheeled onto the treadmill, and an automatic lifter so that the harness can be fitted in sitting and the patient lifted into standing. The harness fits around the trunk and the legs, thereby providing good body weight support. As only one standard sized harness is provided with the unit, it is sometimes difficult to fit large or small individuals. The Spacetrainer weighs the patient and the desired body weight support is dialled up as a percentage of the patient’s body weight. The weight support mechanism permits vertical body movements of up to 12 centimetres without altering the weight support. The design of the unit provides good access to the patient’s legs (Figure 1). The treadmill can run as slowly as 0.1m/s, allowing adequate time to swing the legs through.

The Lite-Gait is a stand-alone support system which is designed for practising over-ground walking with support, although it can also fit over a treadmill. It consists of a frame on wheels from which a patient can be supported via a harness. It has the capacity to lift the patient mechanically from sitting to standing. The harness fits around both the trunk and the legs, thereby providing good support. It
allows differential weight support from each leg, although this feature is not particularly useful in neurological patients. There is no allowance for vertical body movement, therefore the weight support fluctuates as the patient walks. The Lite-Gait frame needs to be pushed across the room by a therapist and since it is quite large, it can be difficult to manoeuvre. There are, however, advantages to practising over-ground walking as opposed to walking on a treadmill when patients are no longer severely disabled.

The Z-Lift is an inverted U-shaped frame incorporating the overhead harness that can be positioned over any treadmill. It does not have the capacity to automatically lift the patient up from sitting. It is necessary, therefore, to manually assist the patient to stand. The vertical posts that support the harness make access to the patient’s legs very difficult. In addition, the harness has no groin straps and fits around the trunk only, which makes body weight support difficult. These features make this system useful for patients whose main problem is poor balance rather than weakness, and who therefore use the harness mainly as a safety measure.

Conclusion

We have found treadmill and harness systems to be an effective way of increasing the amount of walking practice in severely disabled patients following stroke and incomplete spinal cord injury. The TR Spacetrainer incorporates many useful features but is the most expensive. The Lite-Gait and Z-Lift are cheaper but require the purchase of a separate treadmill. Both the TR Spacetrainer and Lite-Gait can mechanically pull the patient up from sitting to standing posture. This is a useful feature in heavy, dependent patients and allows walking practice while complying with the no-lifting policy recently introduced into hospitals. The Lite-Gait has the additional capability of use without a treadmill for walking on a level floor. The main problem encountered with all the systems involves the fit of the harness. Manufacturers need to spend more time on the design of the harness in terms of both support and comfort. Harnesses need to be adjustable and available in different sizes to better cope with patients of different body shapes.

Footnotes (a) TR Spacetrainer, TR Equipment, Transas, Sweden; (b) Lite-Gait, Mobility Research, Arizona, USA; (c) Z-Lift Corporation, Texas, USA

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