Topic: Rehabilitation of gait after stroke

EVIDENCE-BASED LOCOMOTOR TRAINING AFTER STROKE

Waldner A[1], Werner C[2], Hesse S[2]
[1]Villa Melitta, Neurological Rehabilitation, Bolzano/Bozen, Italy
[2]Klinik Berlin, Department of Neurological Rehabilitation, Charité – University Berlin, Germany

Abstract:
Task-specific locomotor training means repetitive practice of gait with the help of a treadmill system with Body-Weight-Support (TT) or gait machines, e.g. Lokomat, Gait Trainer GT I. It intends, in line with modern principles of motor learning, to restore gait in stroke patients. Published controlled trials have been considered.
1. Non-ambulatory patients (in-patients): TT was not superior as compared to the practice of gait on the floor (Cochrane report). For the Lokomat, one study (n=30) did not reveal a superior effect (Husemann, 07). For the GT I two studies included 50 (Tong, 06) and 155 (Pohl, 07) patients; in both studies 4 weeks of GT I training resulted in significantly better gait ability and velocity. The positive effects persisted at follow-up (Pohl, 07, Ng, 08). The Cochrane report "Electromechanical-assisted training for walking after stroke" (Mehrholz, 07) confirmed that electromechanical assisted gait training in combination with physiotherapy effected a superior gait ability.
2. Ambulatory patients (out-patients): Aerobic TT (reaching a target heart rate by gradually increasing speed and inclination) was an effective way of improving speed and endurance in subacute (Eich, 04) and chronic stroke (Macko, 05) patients. In addition cardiovascular fitness improved (Macko, 05). Adverse effects on gait quality (Eich, 04) did not occur. Another protocol applied speed training (Pohl, 02) which resulted in significantly better walking velocity. In summary, gait machines seem to bee a promising option to restore gait in non-ambulatory stroke patients and aerobic or speed TT to improve walking velocity and endurance in ambulatory stroke patients.

1. Introduction

Stroke affects 180 people per 100000 inhabitants in Europe. Restoration of gait is a major aspect of stroke rehabilitation. Three months after stroke, 25% of the surviving subjects remain wheelchair-dependent, and in 50% gait speed and endurance are considerably reduced (Wade et al, 87).
Traditional treatment concepts put their emphasis on tone-inhibiting and gait preparatory manoeuvres assuming a transfer of skill acquisition from one motor task to the other. Gait itself was practised very little, rarely more than 50 to 100 steps per session. Not surprisingly, a large outcome study failed to show a significant improvement of gait function and symmetry in 160 ambulatory subjects following 4 weeks of Bobath treatment (Hesse et al, 94). Modern concepts of motor learning favour a task-specific repetitive approach, i.e. "if you want to walk again, you just have to walk".
Treadmill training with partial body weight support, introduced in the early nineties (Hesse et al, 94) following first reports on paraparetic subjects (Barbeau et al, 94; Wernig et al, 92), was a first step toward intensifying gait practice: the harness substitutes deficient equilibrium reflexes, the body weight reduction takes into account the paresis of the affected lower limb, and the motor-driven belt enforces locomotion. Wheelchair-bound subjects could train up to 1000 steps per session, resulting in a superior effect on gait ability and gait speed in first studies comparing treadmill training to a very conservative Bobath approach (Hesse et al, 95). However, subsequent controlled studies, comparing repetitive gait practice either on the belt or on the floor with aggressive use of braces, failed to show a superior effect of the former (Nilsson et al, 01; Kosak & Reding, 00). The difference in intensity obviously was too small, maybe also due to the fact that treadmill training was very labour intensive, e.g. placing the paretic foot. Currently, treadmill training is used for ambulatory patients to improve their speed and endurance.
To relieve the strenuous effort of the therapists during gait rehabilitation of wheelchair-dependent subjects, two machines, namely the Gait Trainer GT I and the Lokomat, have

been designed. The following article focuses on published controlled trials (RCTs) using those devices. Another paragraph summarizes RCTs on treadmill training of ambulatory stroke patients.

2. The non-ambulatory patient

As soon as possible out of bed into the wheelchair! Analogous to the door-to-needle-time in acute care, we have introduced the bed-to-wheelchair-time on the wards of early rehabilitation as a quality criteria. Rapid verticalisation with the help of a standing frame comes next and once the patient can sustain 5 to 10 min verticalisation and is able to sit on the edge of the bed, locomotor therapy on the Gait trainer GT I can start.

Following a baseline treatment study and an A-B-A versus B-A-B study (A: 2 weeks GT I, B: 2 weeks treadmill, superior effect in group A and less effort for therapists, Werner et al, 02), our group conducted a large multicenter trial, the Deutsche Gangtrainer Studie, DEGAS (Pohl et al, 07). Four centres recruited 155 non-ambulatory first-time stroke patients and assigned them to either group A or B. Group A received 20 min GT I + 25 min physiotherapy (PT), and group B 45 min PT every workday for 4 weeks. The times are net, the patient–therapist contact time was limited to 60 min per session. Responders were those patients who were able to walk (FAC 4 or 5) or who reached a Barthel Index (BI, 0-100) of at least 75. At the end of the treatment significantly more group A patients had become responders: 41 vs. 17 with respect to independent gait ability and 44 vs. 21 with respect to the BI 75. Six months later the superior gait ability persisted. Side effects did not occur.

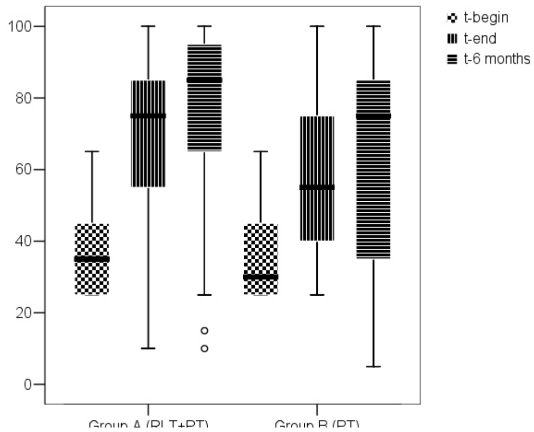

Fig. 1: DEGAS results

Tong et al included 50 acute non-ambulatory stroke patients, assigned to three groups: conventional therapy, locomotor training on the GT I, and locomotor training on the GT I + cycle-dependent Functional Electrical Stimulation (FES) time-locked on the machine (Tong et al, 06). The specific treatment in each group lasted 20 min every workday for 4 weeks; all patients had additional 40-min sessions of physiotherapy. The groups were comparable at study onset, after this therapy both locomotor groups scored significantly better in the 5-m walking speed test, lower limb motor power, and gait ability. The GT I and GT I + FES groups did not differ. A follow-up study six months after the end of the intervention showed a persisting superior gait ability effect in both GT I groups (Ng et al, 2008).


Fig. 2: Gait Trainer GT I

Peurala et al studied 45 ambulatory chronic stroke subjects, assigned to three groups: intensive walking overground, GT I, and GT I + FES. Each session lasted 20 min, every workday for three weeks (Peruala et al, 05). The total mean walking distance was 6900 m and 6500 m in the locomotor groups, as compared to 4800 m in the walking group (p=.027). All chronic patients improved their walking speed and endurance considerably, but the response in the groups did not differ.

For the Lokomat Husemann et al included 30 non-ambulatory acute stroke patients, assigned to conventional gait training or the Lokomat (Husemann et al, 07). Each session lasted 30 min, every workday for 4 weeks. Conventional physiotherapy (30 min sessions) was added in both groups. All patients improved their gait ability and speed, but there was no difference between the two groups. Training on the Lokomat offered no substantial advantage.

Mayr et al conduced a single case design study concerning 16 acute stroke patients following an A-B-A respective B-A-B design with A: Lokomat, and B: physiotherapy. All patients improved over time; the graphics hinted at a faster recovery of gait in the A-phases. Comparisons between groups after each phase, however, have not been reported (Mayr et al, 2007).

Several groups have reported in abstract form so far, on the therapy aided by the use of the Gait Trainer GT I or the Lokomat. A recent Cochrane report polled all available data, concluding that electromechanically assisted gait training in combination with physiotherapy resulted in significantly improved chances to regain independent walking ability. (Mehrholz et al, 07).

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In conclusion, locomotor training using gait machines is promising in non-ambulatory subjects and the Gait Trainer GT I shows the strongest evidence. A comparison of both devices is highly warranted in respect to clinical practicability, effectiveness and cost efficiency. The future will see more sophisticated machines (e.g. Haptic Walker or EO-robot enabling the repetitive practice of stair ascent/descent) and virtual reality applications.

3. The ambulatory patient

In the past, improvement of gait quality was the major goal. In the meantime, gait velocity, endurance and cardiovascular fitness have emerged as equally important therapy targets. Speed or aerobic treadmill training of the harness-secured patient (the harness for security reasons is an absolute necessity) is a perfect tool.

Speed training is the step-wise increase of belt speed in 10% increments starting from the self-adopted velocity. In aerobic training, a training heart rate (THR) is set, following ergometry and with the help of the Karvonen formula: (Hfmax-Hfrest) x 0.6 (constant) + Hfrest. If ergometry is not possible, the clinician may apply the simple equation: 180 – age, in case of betablocker further reduction of 15 beats per min. The socalled heart rate reserve (HRR) depends on the constant of the Korvonen formula, i.e. the HRR is 60% in the above mentioned formula; initially patients start at a HRR of 40%. By systematically increasing belt speed and inclination, the patient reaches his/her target heart rate. The belt speed correlates positively with the facilitation of various weight-bearing muscles and the gait efficiency (Hesse et al, 01), i.e. a patient consumes less energy per distance covered when he walks fast. An inclination of 6% or 8% results in a longer stride and better gait symmetry (Werner et al, 07). Accordingly neither speed nor inclination worsen gait quality, on the contrary!

Pohl et al studied 60 subacute ambulatory stroke subjects, assigned to three groups: conventional gait training, treadmill training with a modest (<20%) increase of belt speed and systematic speed training, 12 sessions over 12 weeks in all three groups in addition to regular physiotherapy (Pohl et al, 02). The mean walking velocity increased from 0.61 to 1.63 m/s in the experimental group, from 0.66 to 0.97 in the conventional physiotherapy group, and from 0.66 to 1.22 in the treadmill group with a modest increase in belt speed. The differences were significant in favour of speed training, follow-up data were not given.

Eich and his team included 50 acute stroke patients, assigned either to aerobic treadmill training or conventional physiotherapy, 30 min every workday for six weeks in addition to 30 min of additional physiotherapy in both groups (Eich et al, 04). Both groups were homogeneous at study onset; after the therapy the experimental group improved their gait speed by an average of + 0.31 m/s and their endurance by an average of 91 m,

whereas the control group had gained 0.16 m/s and 56 m. At follow-up, the differences in favour of the experimental group persisted. The gait quality did not differ between the two groups at any time, which did not support often expressed fears of therapists that walking fast could worsen the gait pattern of hemiparetic subjects. Macko et al investigated 61 chronic ambulatory stroke patients whose stroke dated back at least six months (Macko et al, 05). The experimental group performed 40-min of aerobic treadmill training three times a week for six months; the initial HRR was 40% being increased by 5% every second week. The control group did stretching exercises and 5 min of treadmill walking at 40% HRR, again three times a week for six months. Twenty-five subjects of the experimental group and 20 of the control group finished the programme; the aerobic fitness and maximum gait distance differed significantly in favour of the experimental group.
Other training possibilities for the harness-secured patient on the treadmill are walking backwards to selectively bend the knee while keeping the hip fully extended during the terminal stance phase, sideward walking in case of adductor spasticity, and mastering perturbations like sudden stops, obstacles etc.

4. Summary

In gait rehabilitation after stroke a task-specific treatment approach, ("if you want to walk again, you just have to walk") is most promising. Gait machines offer wheelchair-dependent subjects the chance to practise complex gait cycles repetitively without overstressing therapists. The electromechanical gait trainer GT I presents the strongest evidence. For ambulatory patients, speed and endurance are highly relevant (the control of traffic lights in Bolzano/Bozen, for instance, is based on a mean walking velocity of 1 m/s). Aerobic treadmill training is a perfect tool for reaching a target heart rate by systematically increasing belt speed and inclination. Locomotor therapy is not meant to replace conventional physiotherapy, but to be complementary.

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