Evidence-based locomotor training after stroke

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Introduction

Stroke affects 180 subjects per 100.000 inhabitants in the EC. 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 relevant 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. "who wants to regain walking has to walk."

Treadmill training with partial body weight support, introduced in the early nineties (Hesse *et al*, 94) following first reports in paraparetic subjects (Barbeau *et al*, 94; Wernig *et al*, 92), was a first step to intensify gait practice: the harness substituted for the deficient equilibrium reflexes, the body weight reduction of the often obese patients took into account the paresis of the affected lower limb, and the motor-driven belt enforced 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 vs. a very conservative Bobath approach (Hesse *et al*, 95). Subsequent controlled studies, comparing the repetitive gait practice either on the belt or on the floor assisted by the aggressive use of braces, however failed to show a superior effect (Nilsson *et al*, 01; Kosak & Reding, 00). The difference in intensity obviously was too little, maybe also attributable to the fact that treadmill training was very labor intensive, e.g. when placing the paretic foot. Currently, treadmill training is applied for ambulatory patients to improve speed and endurance.

To relieve the strenuous effort of the therapists during gait rehabilitation of wheelchair-dependent subjects, machines, namely the Gait Trainer GT I and the Lokomat, were designed. The following article will focus on published controlled trials (RCTs) using those devices. Another paragraph will summarize RCTS on treadmill training of ambulatory stroke patients.

The non-ambulatory patient

As soon as possible out of the bed into the wheelchair! Analogous to the door to needle time in the 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 a standing frame adds to it, once the patient can sustain 5 to 10 min verticalisation and is able to sit at the edge of the bed, locomotor therapy starts on the Gait trainer GT I.

Following a baseline treatment study and an A-B-A respective B-A-B study (A: 2 weeks GT I, B: 2 weeks treadmill, superior effect in group A and less effort for the 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, allocated 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 with 60 min per session. Responders were those patients who became 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.

Tong *et al* had 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, 40-min sessions of physiotherapy were additional for all patients. The groups were comparable at study onset, after the intervention 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.

Peurala *et al* had studied 45 ambulatory chronic 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

Figure 1. – Electromechnical Gait Trainer GT I

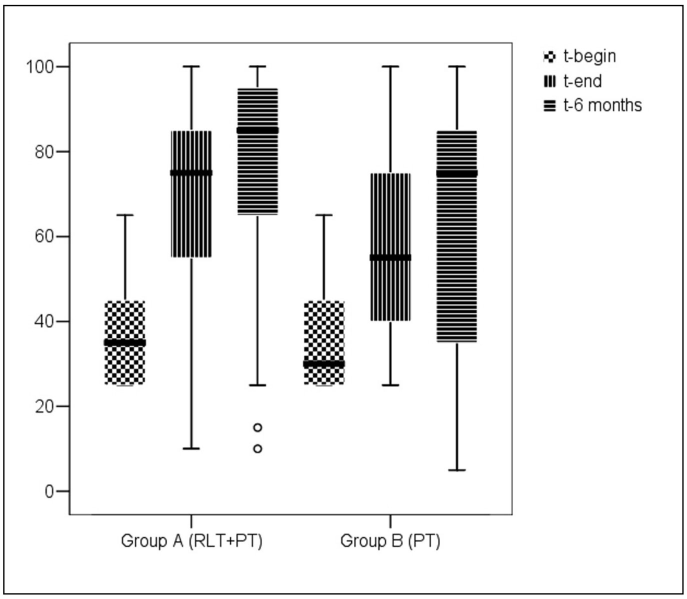

Figure 2. – Box plot of the Functional Ambulation Category (0-5, 0 = unable to walk, 5 = able to walk independently including stair climbing) of the experimental (GT I + Physiotherapy) and of the conventional (Physiotherapy) group at study onset, end of intervention and at follow-up

Lokomat (Husemann *et al*, 07). Each session lasted 30 min, every workday for 4 weeks. Conventional physiotherapy (40 min sessions) was additional in both groups. The data were comparable at study onset, all patients improved their gait ability and speed, but the groups did not differ, i.e. the training on the Lokomat was not superior.

Several groups have reported in abstract form so far on the therapy with the help of the GT I or the Lokomat. A Cochrane report is expected at the end of the year 2007 (Mehrholz *et al*, 06). In conclusion, locomotor training using gait machines is promising in non-ambulatory subjects , the GT I has the strongest evidence, a comparison of both devices is warranted.

The ambulatory patient

In former times, 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 (please do not forget the harness!) patient is a perfect tool.

Speed training contains 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, either following ergometry and with the help of the Karvonen formula: (Hfmax-Hfrest) x 0.6 (constant) + Hfrest. If an ergometry is not possible, the clinician may apply the simple equation: 180 - age, in case of betablocker further reduction for 15 beats per min. The so called 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 target heart rate. The belt speed positively correlates 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 a better gait symmetry (Werner *et al*, 07). Accordingly neither speed nor inclination worsen the 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, 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 the speed training, follow-up data were not given.

Eich and co-workers included 50 acute stroke patients, assigned either to aerobic treadmill training or conventional physiotherapy, 30 min very 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 intervention the experimental group had improved their gait speed for a mean of + 0.31 m/s and their endurance for a mean of 91 m, 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 insult dated back at least six months (Macko *et al*, 05). The experimental group performed a 40-min aerobic treadmill training three times a week for six months, the initial HRR was 40%, being increased for 5% every second week. The control group received 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 and 20 of the control group finished the program, the aerobic fitness and maximum gait distance differed significantly in favour of the experimental group.

Summary

In gait rehabilitation after stroke a task-specific treatment approach, ("who wants to regain walking, has 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 has 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 to reach a target heart rate by systematically increasing belt speed and inclination. Locomotor therapy does not intend to replace conventional physiotherapy, it is complementary.

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 are considered 1. Non-ambulatory 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 a significantly better gait ability and velocity. The positive effects persisted at follow-up (Pohl, 07). 2. Ambulatory patients: Aerobic TT (reaching a target heart rate by gradually increasing speed and inclination) was effective to improve 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 a significantly better walking velocity. In summary, gait machines seem promising to restore gait in non-ambulatory and aerobic or speed TT to improve walking velocity and endurance in ambulatory stroke patients.

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