Stroke
Volume 26, Issue 6, June 1995; Pages 976-981
https://doi.org/10.1161/01.STR.26.6.976

ARTICLE

Treadmill Training With Partial Body Weight Support Compared With Physiotherapy in Nonambulatory Hemiparetic Patients

S. Hesse, C. Bertelt, M. T. Jahnke, A. Schaffrin, P. Baake, M. Malezic, and K. H. Mauritz

ABSTRACT: *Background and Purpose* Treadmill training with partial body weight support is a new and promising therapy in gait rehabilitation of stroke patients. The study intended to investigate its efficiency compared with gait training within regular physiotherapy in nonambulatory patients with chronic hemiparesis.*Methods* An A-B-A single-case study design compared treadmill training plus partial body weight support (A) with physiotherapy based on the Bobath concept (B) in seven nonambulatory hemiparetic patients. The minimum poststroke interval was 3 months, and each treatment phase lasted 3 weeks. Variables were gait ability assessed by the Functional Ambulation Category, other motor functions tested by the Rivermead Motor Assessment, muscle strength assessed by the Motricity Index, muscle tone rated by the Modified Ashworth Spasticity Scale, and gait cycle parameters.*Results* Treadmill training was more effective with regard to restoration of gait ability ($P<.05$) and walking velocity ($P<.05$).

Other motor functions improved steadily during the study. Muscle strength did not change, and muscle tone varied in an unsystematic way. The ratio of cadence to stride length did not alter significantly. *Conclusions* Treadmill training offers the advantages of task-oriented training with numerous repetitions of a supervised gait pattern. It proved powerful in gait restoration of nonambulatory patients with chronic hemiparesis. Treadmill training could therefore become an adjunctive tool to regain walking ability in a shorter period of time.

Key Words: gait ■ hemiplegia ■ rehabilitation

Restoration of gait is one of the goals in the rehabilitation of nonambulatory hemiparetic patients. To reach that aim, therapists apply either a traditional functional approach with strengthening and practicing of single movements or various neurofacilitation techniques, such as the Brunnstrom technique with synergistic movements, proprioceptive neuromuscular facilitation with spiral and diagonal movements, and neurodevelopmental (Bobath) therapy with reflex inhibitory movements.[1] These methods are complex and do not stress gait practice per se.

The performance of complete gait movements on a treadmill with partial body weight support as a task-oriented approach could restore the gait of nonambulatory patients faster and with less effort for the therapists. Such a treatment in nine nonambulatory paraparetic patients enabled them to walk short distances after 1 to 7 months,[2] and one study even demonstrated the induction of an almost normal electromyographic pattern during assisted gait on the treadmill in a patient with clinically complete paraplegia.[3] This, however, was functionally not effective.

For hemiparetic patients, a single case report documented improved step-length symmetry in a patient with chronic hemiparesis during treadmill training without body weight support compared with regular physiotherapy.[4] Another study showed that acute stroke patients had good treatment compliance and were able to withstand a mean treatment duration of 44.8 minutes.[5] In a multiple baseline study, nine hemiparetic patients who had required firm continuous support reached independent gait after 25 treadmill sessions with body weight support.[6]

The latter study with additionally applied treadmill treatment could not distinguish between its effects and those of a comprehensive physiotherapeutic program. To assess the efficiency of the two approaches separately, the hemiparetic patients in this study received the treadmill treatment and regular physiotherapy one after another. Because the patients had chronic hemiparesis and had not regained their gait ability despite previous comprehensive physiotherapy, they were treated with the treadmill during the first phase, with physiotherapy during the second phase, and again with the treadmill during the third phase.

SUBJECTS AND METHODS

This study, which was approved by the local ethical committee, was entered and completed by seven inpatients who gave informed consent (Table 1; 6 men, 1 woman; mean age, 60.3 years [range, 52 to 72 years]). Right hemiparesis was found in 3 and left hemiparesis in 4 patients. The etiology in all cases was ischemia in the region of the middle cerebral artery. The minimum time after stroke before study admission was 3 months, and the mean interval was 176.8 days (range, 91 to 362 days). Four had impaired limb proprioception, 4 had sensory motor neglect syndrome, and 3 had pusher syndrome, ie, they pushed the trunk to the affected side while standing and walking.[7] Two could not walk at all, 3 required firm continuous support from 1 person, and 2 required moderate continuous or intermittent support. Exclusion criteria included additional neurological and/or orthopedic deficits that impaired ambulation or heart failure classified as greater than New York Heart Association grade 2.

The patients were treated in an A-B-A single-case study design with treadmill training with partial body weight support (A), regular physiotherapy based on the Bobath concept (B), and another treadmill phase (A), each lasting 3 weeks (15 sessions). There was not enough time for a fourth phase because of the restricted length of stay dictated by the national health policy. The patients were treated 30 minutes daily during the treadmill phase and 45 minutes during the physiotherapy period. No other locomotion therapy was applied during the treadmill treatment.

The patients walked on a motor-driven treadmill while suspended by a modified parachute harness, which allowed free movement of the limbs. A system similar to that described previously was used.[8] The body weight was released for 30% at the beginning of the study, which was reduced as rapidly as possible to ensure full weight bearing. This was accomplished within 4 to 15 days; however, patients remained secured in the harness and were assisted by one or two therapists. The clinical criterion for the amount of body weight support was the patient's ability to carry the remaining load on the paretic leg during the single-support phase. If the weight release was too low, patients simply tended to sit in the harness, which was strictly to be avoided. Treadmill speed was raised from the initial 0.07

to 0.11 m/s to the final 0.18 to 0.22 m/s according to the patient's ability. Gait speeds during treadmill training were chosen well below assisted over-ground walking velocities to permit gait corrections and longer training sessions without interruptions. The therapist stabilized the trunk and pelvis, initiating the weight shift and pelvic rotation at the beginning. Another therapist helped to move the paretic limb and secured it during the stance phase when necessary. A correct, symmetrical gait pattern was stressed throughout the treatment. During the physiotherapy phase, patients were treated by individual physiotherapy based on the Bobath concept.[7] The predominant goal of the physiotherapists was likewise the improvement of gait performance, while the occupational therapists concentrated on competence in the activities of daily living and motor function of the upper extremity. The additional comprehensive rehabilitation program remained comparable during all three phases.

The patients were examined by the Functional Ambulation Category (FAC), the Rivermead Motor Assessment (gross function and leg/trunk sections), the Motricity Index, and the Modified Ashworth Spasticity Scale of the affected upper and lower limb once a week.[9]

The FAC distinguished six levels of required support during gait without taking into account any aid used. The test was performed with a cane but without orthoses. Levels were defined as follows: level 0, the patient cannot walk at all or requires the help of two or more people; level 1, the patient needs continuous support from one person who helps to carry the patient's weight and helps with balance; level 2, the patient is dependent on the continuous or intermittent support of one person to help with balance or coordination; level 3, the patient needs only verbal supervision; level 4, help is required on stairs and uneven surfaces; and level 5, the patient can walk independently anywhere. The FAC test was based on a walking distance of 15 m.

The Rivermead Motor Assessment score for the leg and trunk and gross function tested motor functions in a hierarchical order with 10 maneuvers assessed within the leg and trunk section. For the gross function assessment, 13 maneuvers including sitting, transfers, walking 10 m, climbing, running, and hopping were tested. The Motricity Index quantified motor strength of the affected upper and lower limb (grade 0 to 100). The Modified Ashworth Spasticity Scale graded muscle tone from 0 to 5, with 0 for no increase in muscle tone to 5 for a rigid joint. It was applied to the ankle and wrist with the patient in a supine position. All clinical tests were applied by two independent physiotherapists who were not blinded for the treatment phases. Both were experienced Bobath therapists; one of them did not belong to the scientific staff but was a member of the physiotherapy department.

Kinesiological measurements of gait were performed twice a week. For assessment of gait speed, cadence, and stride length, the patients walked 10 m with their maximum gait velocity. One therapist was involved in the task, and she was carefully instructed not to push the patients forward but merely to prevent them from falling.

For the ordinal-scaled values, increments between consecutive measurements were computed and tested for homogeneity with the use of the nonparametric Friedman test. A nonsignificant result meant that increments were constant over training phases (ie, the profile was linear) when averaged across subjects. In contrast, a significant result meant that the average profile was nonlinear; in this case a similar analysis was performed for the increments of the previously computed increments to evaluate whether the acceleration was constant.

A MANOVA was performed for the continuous variables (velocity, cadence, stride length). If the two therapies were either ineffective or equally effective, then the corresponding trend in time should be a linear one or a second-degree polynomial, ie, a parabola. If the two therapies were different, the profile over time should have at least one point of deflection (ie, the corresponding regression curve would require a minimum of a third-degree polynomial). For all tests an α-level of 5% was assumed. We used the standard software package SYSTAT.

RESULTS

Table 2 shows the FAC levels, Rivermead Motor Assessment scores (gross function, leg/trunk), Modified Ashworth Spasticity Scale grades of the affected ankle and wrist, and Motricity Index scores of the paretic upper and lower limb of each measuring point, ie, at the beginning of the study and at the end of each week.

The FAC levels only improved during the treadmill phases, with a mean of 1.14 points during the first and 1.29 points during the second A phase. Treadmill training was superior to regular physiotherapy with regard to improvement of gait ability tested by the FAC ($P<.05$, Fig 1).

At the beginning of the study patients needed the continuous support of 2 persons or 1 person or the intermittent support of 1 person. After the study 3 patients walked independently and needed help on stairs, and 3 needed verbal supervision.

The mean Rivermead score for gross function assessment improved a mean of 0.71 points during the first A phase, 0.86 points during the B phase, and 1.14 points during the second A phase. No superiority of any treatment was found.

The mean Rivermead score for the leg and trunk section improved a mean of 1.43 points during the first A phase, 0.43 points during the B phase, and 0.86 points during the second A phase (Fig 2). No therapy proved to be superior.

The Ashworth scores for assessment of ankle dorsiflexion and wrist extension displayed a within-subject variability of up to two grades from one measuring point to the next. A consistent trend could not be detected, and no treatment proved more effective than the other.

The motor strength of the upper and lower affected extremities was constant in 5 patients throughout the study and only changed slightly in the remaining 2 patients. We did not determine the superiority of any treatment. Table 3 displays the gait velocity, cadence, and stride length of individual subjects at each measuring point, ie, twice per week.

Without exception the patients increased their gait velocity, with a mean of 150.4% during the first A phase. During the B phase walking speed did not change consistently. During the second A phase all patients increased their gait velocity, with a mean of 43.5%. Treadmill training was more effective than physiotherapy in this regard (P<.05, Fig 3).

Cadence and stride length increased, with a mean of 61.4% for stride frequency and 47.2% for stride length during the first A phase. In the subsequent B phase no consistent trend could be detected. In the second A phase the improvement of both variables did not reach a significant level because of large within-subject variability.

DISCUSSION

The gait capability of all patients, as assessed by the FAC test, increased during the study. The patients could walk independently at the end of the study, with three needing help on stairs and three needing verbal supervision. Improvement of gait ability exclusively occurred during the treadmill training in both the first and second A phase. Treadmill training was therefore superior to physiotherapy with regard to restoration of gait function. Thus far, studies comparing different conventional concepts in physiotherapy were unable to detect any superiority with regard to general mobility.[10 11 12 13 14 15]

Although we cannot rule out a contribution of spontaneous recovery, particularly in these relatively young patients, spontaneous recovery alone cannot account for the temporal trend actually observed, which significantly differed from a first- or second-degree polynomial (Fig 1). In addition, five patients suffered from a neglect syndrome and three patients from a pusher syndrome, both of which are unfavorable conditions in a patient attempting to regain walking ability.[7 16]

Gait velocity improved in parallel with gait ability, which is in accordance with the reported good correlation of these parameters.[17] This finding is even more important in view of the fact that all patients were only able to walk with assistance in the beginning of the study, while in the course of the study gait velocities were measured without external support in correspondence to their gait improvement. Cadence and stride length showed a similar pattern; the trend for improvement during the second treadmill phase was not statistically significant because of within-subject variability. The ratio of cadence to stride length remained unchanged, thus indicating that walking speed increased in a physiological manner.[18]

Motor functions tested within the leg and trunk section of the Rivermead test (eg, either stepping on and off a block, tapping with the unaffected foot while standing on the affected leg, or active dorsiflexion of the affected ankle) improved markedly during the first A phase; however, improvement during the second A phase was not significantly better than during the previous physiotherapy. Physiotherapists practice the rudiments of walking in an isolated manner. It may be concluded that patients were more effectively trained in the functional context of walking on the treadmill, at least in the beginning of rehabilitation.

The items tested within the gross function section, such as sitting up, standing up, and transfer, continuously improved during the study. Physiotherapists place particular emphasis on training these abilities. It is surprising that patients also improved in this respect during treadmill training, which constituted two thirds of the entire treatment period. Muscle tone showed high within-subject variability during the study. There are many tone-modulating internal and external factors that were not under the control of the investigators.

Volitional muscle strength, tested with the patient in a supine position, did not change, which was in accordance with a previous study.[6] Therefore, motor power is either not the primary factor in gait improvement or is a question of reflex-activated muscular strength, which was not measured with that method.

There are indications for a spinal stepping generator in vertebrates.[19] One study showed that spinal kittens could be successfully trained on a treadmill to perform full weight-bearing hind limb stepping movements.[20] In primates, however, intact reticulospinal motor pathways descending in the ventral section of the spinal cord are required for stepping and walking.[21] These conditions were met in the hemiparetic patients, so that treadmill training might have stimulated the presumed spinal motor generators. In addition, intact supraspinal centers via ipsilateral descending motor pathways might have also been involved in the observed treatment effect.

Treadmill training has the advantage of being a task-oriented exercise in contrast to pure physiotherapy. Therapists trained in neurodevelopmental therapy walk with the patients in a slow and controlled manner only after a relatively long preparatory period during which tone-inhibiting maneuvers and training of balance during sitting and standing prevail.[7] It might be argued that in the comparatively short period of physiotherapy, marked effects could not have been expected because this type of treatment does not place particular emphasis on short-term efficacy with regard to independent gait and walking speed. Therefore, it cannot be ruled out that on a substantially larger time scale the Bobath approach might have finally resulted in a similar functional improvement. Treadmill training, on the other hand, is a task-oriented training that stresses the restoration of an independent gait with reasonable speed, and it must be admitted that these aspects are predominantly assessed by the FAC scale and kinesiological measurements. Nevertheless, these are not “academic” scores but measurements of important aspects in the daily life of the patients. The authors do not claim that as a consequence of the present study treadmill training can substitute for regular physiotherapy, but it may function as an adjunctive therapy to regain walking ability in a shorter period of time.

Walking as early as possible and numerous repetitions of the same basic patterns support motor learning in treadmill training.[22] The therapist can concentrate on supervising gait patterns rather than helping patients to carry their body weight. An experienced physiotherapist was responsible for training on the treadmill and applied the same principles concerning supervision and correction of gait as are applied in normal training. Therefore, an “unphysiological” gait pattern with the risks of contracture and arthrosis was not likely to occur. On the contrary, the harness provided a sense of security for the patient, thus preventing unwanted mass synergies related to the fear of falling. From a psychological point of view it is important that the patients have early walking experience so that they can walk relatively normally.

In conclusion, treadmill training was more effective with regard to restoration of gait ability and walking velocity. It offers the advantages of task-oriented training with numerous repetitions of a supervised gait pattern. Therefore, treadmill training could become an adjunctive tool to regain walking ability in a shorter time. However, based on the limited sample size thus far available, conclusions regarding rehabilitation strategies in general must be drawn with caution. In particular, further studies in patients with acute hemiparesis and systematic variation of the treatment parameters, such as treadmill speed and percentage of body weight support, are needed.

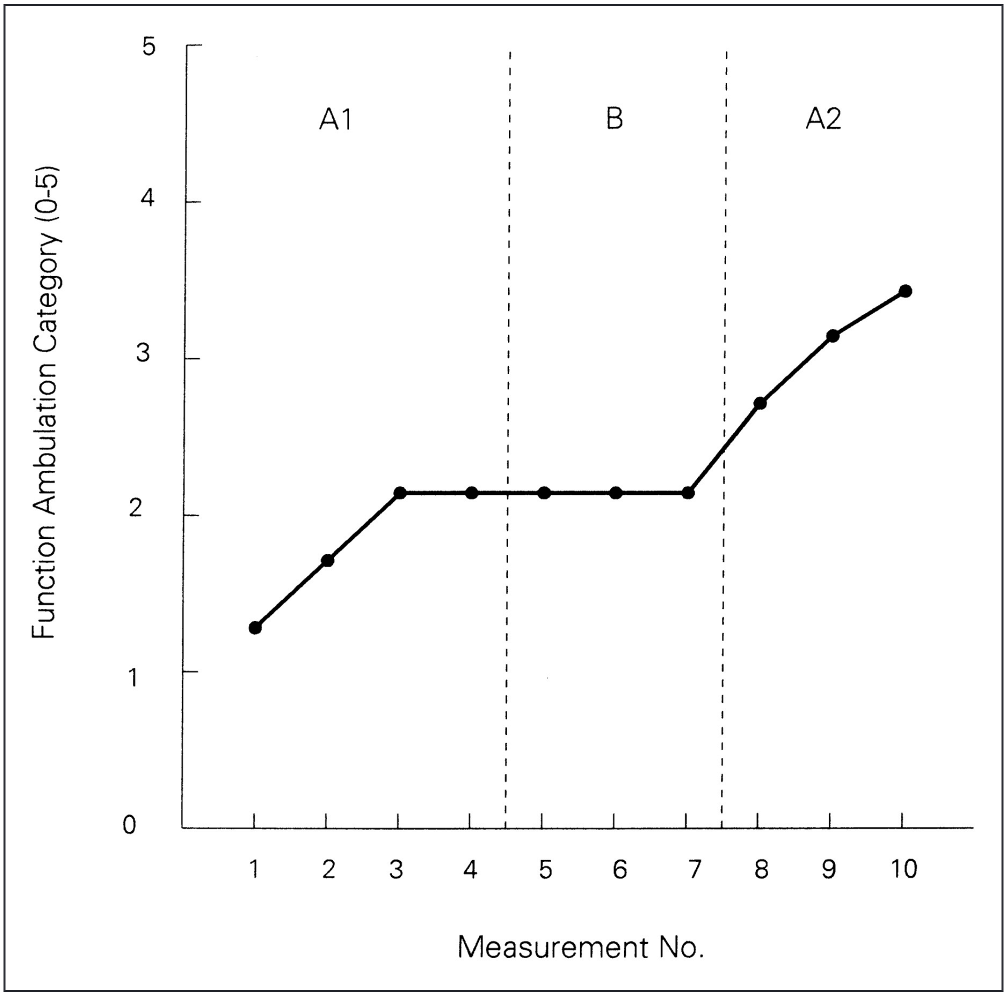

Figure 1. Line graph shows mean Functional Ambulation Category scores over time. Treadmill training applied during the A1 and A2 phases was more effective than physiotherapy applied during the B period (*P*<.05).

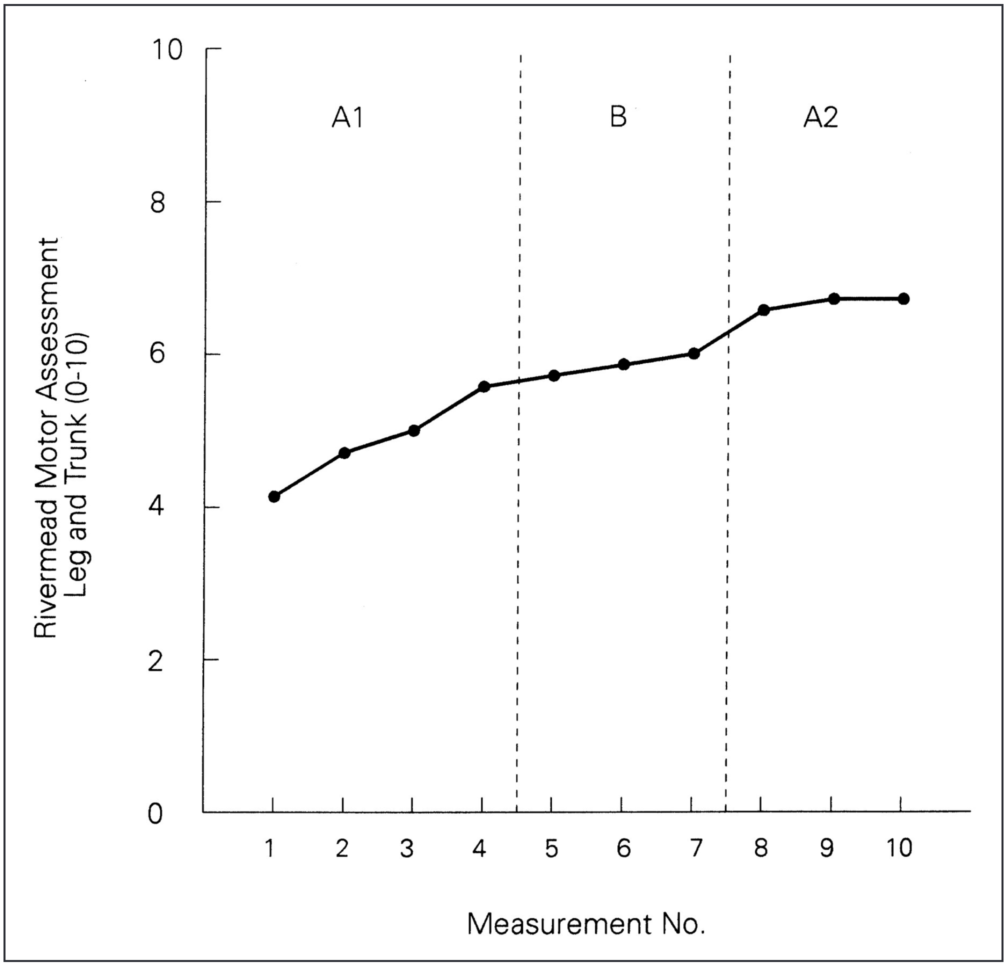

Figure 2. Line graph shows mean Rivermead Motor Assessment scores of the leg and trunk section over time. No treatment proved to be superior. A1 and A2 indicate treadmill training with partial body weight support; B, physiotherapy based on the Bobath concept.

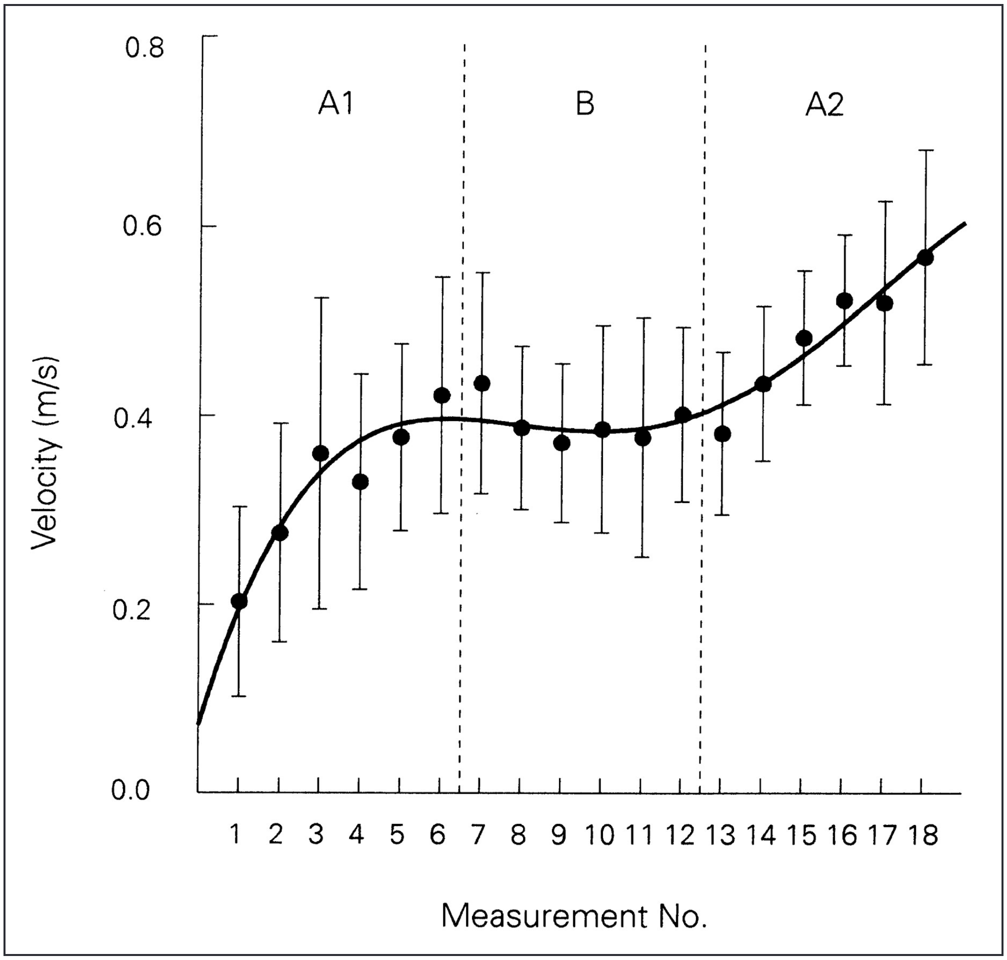

Figure 3. Line graph shows mean (±SD) walking velocity over time. Treadmill training applied during the A1 and A2 phases was more effective than physiotherapy applied during the B period (*P*<.05).

Table 1. Patient Demographics and Initial Functional Ambulation Category Scores at Time of Entry Into the Study (Table view)

Pt	Age, y	Sex	Side	Etiology	Onset, d	Neglect Syndrome	Sensory Lesions	Pusher Syndrome	FAC Score
1	72	M	Right	Ischemia	91	Absent	Absent	Absent	2
2	52	M	Right	Ischemia	362	Present	Absent	Absent	2
3	54	F	Left	Ischemia	97	Present	Present	Present	1
4	64	M	Right	Ischemia	204	Present	Present	Present	0
5	71	M	Left	Ischemia	170	Absent	Present	Absent	1
6	52	M	Left	Ischemia	102	Present	Present	Absent	1
7	57	M	Left	Ischemia	215	Present	Absent	Present	0

Pt indicates patient; FAC, Functional Ambulation Category.

Table 2. Scores of Gait Ability, Motor Function, Spasticity, and Motor Strength of All Patients at Each Measuring Point (Table view)

Pt	Gait Ability FAC (0-5)	Gross Function RMAG (0-13)	Leg and Trunk RMALT (0-10)	Muscle Tone, Ankle Ashworth (0-5)
1	2 2 2 2 - 2 2 2 - 2 3 3	4 5 5 5 - 5 5 5 - 5 6 7	3 3 4 6 - 6 6 6 - 6 7 8	2 1 3 1 - 1 3 2 - 1 3 2
2	3 3 3 3 - 3 3 3 - 3 4 4	5 6 7 7 - 7 7 7 - 7 7 7	4 4 4 5 - 5 5 5 - 7 7 7	4 4 4 4 - 2 3 3 - 4 3 3
3	1 1 2 2 - 2 2 2 - 3 3 4	5 5 5 5 - 5 5 7 - 7 8 9	3 4 5 6 - 7 7 7 - 7 7 7	4 3 3 4 - 4 3 4 - 3 3 3
4	0 1 1 1 - 1 1 1 - 2 2 3	5 5 5 5 - 5 5 5 - 5 6 6	3 3 3 3 - 3 4 5 - 5 5 5	4 2 2 4 - 4 3 3 - 3 3 3
5	1 2 2 2 - 2 2 2 - 2 3 3	5 5 5 5 - 6 6 6 - 6 6 6	6 8 8 8 - 8 8 8 - 8 8 8	1 1 2 1 - 3 1 1 - 2 3 2
6	1 2 3 3 - 3 3 3 - 4 4 4	5 5 6 7 - 8 9 10 - 10 10 10	6 7 8 7 - 8 8 8 - 8 8 8	4 4 4 3 - 3 3 2 - 3 4 3
7	0 1 2 2 - 2 2 2 - 2 3 3	4 4 4 4 - 4 4 5 - 5 6 6	3 3 4 3 - 3 3 3 - 4 4 4	2 2 2 2 - 2 2 2 - 2 1 1

Pt	Muscle Tone, Wrist Ashworth (0-5)	Muscle Strength, Arm MI (0-100)	Muscle Strength, Leg MI (0-100)
1	1 1 1 1 - 3 3 3 - 3 2 2	40 40 40 40 - 40 40 40 - 40 40 40	43 43 43 43 - 43 43 43 - 43 43 43
2	2 1 3 1 - 2 2 2 - 2 1 2	1 1 1 1 - 1 1 1 - 1 1 1	24 24 24 29 - 29 29 29 - 29 29 29
3	0 2 1 2 - 2 2 2 - 2 2 2	28 28 28 28 - 28 28 28 - 28 28 28	29 29 29 29 - 29 29 29 - 34 34 34
4	4 4 3 3 - 3 3 3 - 3 4 3	1 1 1 1 - 1 1 1 - 1 1 1	24 24 24 24 - 24 24 24 - 24 24 24
5	2 2 1 1 - 1 3 3 - 2 2 3	40 40 45 45 - 45 45 54 - 54 54 54	48 48 59 64 - 64 64 64 - 64 64 64
6	4 4 4 4 - 4 4 4 - 3 3 4	1 1 1 1 - 1 1 1 - 1 1 1	38 38 38 38 - 38 38 38 - 38 38 38
7	4 3 4 3 - 3 3 3 - 3 3 3	15 15 15 15 - 15 15 15 - 15 15 15	34 34 34 34 - 34 34 34 - 34 34 34

Pt indicates patient; FAC, Functional Ambulation Category; RMAG, Rivermead Motor Assessment (gross function); RMALT, Rivermead Motor Assessment (leg and trunk); Ashworth, Modified Ashworth Spasticity Scale; and MI, Motricity Index. Values are scores at the beginning of the study and at the end of each week of each phase (A1 [treadmill training with partial body weight support], B [physiotherapy based on the Bobath concept], and A2 [treadmill training with partial body weight support]).

Table 3. Gait Parameters of Each Patient and Their Mean Values at Each Measuring Point (Table view)

Pt		Phase		Velocity, m/s							Cadence, steps/min							St
1		A1		0.09	0.15	0.25	0.25	0.29	0.34		40	40	52	48	62	70		0.
		B		0.36	0.34	0.35	0.45	0.33	0.40		67	73	69	76	68	73		0.
		A2		0.38	0.48	0.46	0.53	0.53	0.59		74	83	80	85	82	85		0.
2		A1		0.33	0.37	0.48	0.39	0.39	0.39		70	69	71	74	72	74		0.
		B		0.34	0.33	0.38	0.44	0.40	0.39		72	64	62	65	78	67		0.
		A2		0.35	0.40	0.44	0.48	0.50	0.49		66	62	65	70	74	72		0.
3		A1		0.31	0.37	0.37	0.44	0.40	0.39		62	67	67	81	70	74		0.
		B		0.48	0.36	0.36	0.26	0.24	0.25		71	64	62	57	51	50		0.
		A2		0.29	0.37	0.39	0.42	0.34	0.42		56	67	67	72	58	72		0.
4		A1		0.11	0.14	0.16	0.15	0.29	0.30		33	34	40	44	60	62		0.
		B		0.27	0.26	0.24	0.28	0.28	0.48		65	57	56	64	60	53		0.
		A2		0.45	0.40	0.57	0.60	0.53	0.60		68	72	83	83	82	88		0.
5		A1		0.14	0.26	0.59	0.38	0.42	0.63		41	54	85	65	65	86		0.
		B		0.59	0.50	0.50	0.50	0.40	0.33		95	84	66	87	74	70		0.
		A2		0.30	0.40	0.50	0.53	0.48	0.49		60	67	81	82	77	87		0.
6		A1		0.28	0.43	0.48	0.45	0.56	0.56		53	68	74	76	77	77		0.
		B		0.57	0.48	0.45	0.53	0.62	0.53		79	77	79	85	90	88		0.
		A2		0.53	0.59	0.56	0.59	0.69	0.77		86	95	87	90	92	92		0.
7		A1		0.16	0.21	0.19	0.25	0.29	0.33		31	40	31	48	61	58		0.
		B		0.38	0.43	0.37	0.30	0.33	0.42		58	73	69	56	58	68		0.
		A2		0.33	0.45	0.50	0.55	0.59	0.62		56	79	84	93	85	90		0.
Mean		A1		0.20	0.28	0.36	0.33	0.38	0.42		47	53	60	62	67	72		0.
		B		0.43	0.39	0.38	0.39	0.37	0.40		72	70	66	70	68	67		0.
		A2		0.38	0.44	0.49	0.53	0.52	0.57		67	75	78	82	79	84		0.

Pt indicates patient; A1 and A2, treadmill training with partial body weight support, phases 1 and 2; B, physiotherapy based on the Bobath concept.

ARTICLE INFORMATION

Received November 28, 1994; revision received January 17, 1995; accepted March 13, 1995.

Note

Reprint requests to Stefan Hesse, MD, Klinik Berlin, Kladower Damm 223, 14089 Berlin, Germany.

Affiliations

From the Klinik Berlin, Department of Neurological Rehabilitation, Free University Berlin (Germany).

Acknowledgments

This study was supported by grant 91.050.1 from the Wilhelm-Sander-Stiftung, Neustadt/Donau, and the Kuratorium ZNS. The authors are indebted to the Department of Physiotherapy of Klinik Berlin and Daniela Lücke for their help with the study.

REFERENCES

1. Dewald JPA. Sensorimotor neurophysiology and the basis of neurofacilitation therapeutic techniques. In: Brandstater ME, Basmajian JV, eds. *Stroke Rehabilitation*. 1st ed. Baltimore, Md: Williams & Wilkins; 1987:109-183.
2. Wernig A, Müller S. Laufband locomotion with body weight support improved walking in persons with severe spinal cord injuries. *Paraplegia.* 1992;*30*:229-238. PubMed.
3. Dietz V, Colombo G, Jensen L. Locomotor activity in spinal man. *Lancet.* 1994;*344*:1260-1263. Crossref. PubMed.
4. Waagfjörd J, Levangle PK, Certo CME. Effects of treadmill training on gait in a hemiparetic patient. *Phys Ther.* 1990;*70*:549-560. Crossref. PubMed.
5. Malouin F, Potvin M, Prevost J, Richards CL, Wood-Dauphinee S. Use of an intensive task-oriented gait training program in a series of patients with acute cerebrovascular accidents. *Phys Ther.* 1992;*72*:781-793. Crossref. PubMed.
6. Hesse S, Bertelt C, Schaffrin A, Malezic M, Mauritz KH. Restoration of gait in nonambulatory hemiparetic patients by treadmill training with partial body weight support. *Arch Phys Med Rehabil.* 1994;*75*:1087-1093. Crossref. PubMed.
7. Davies PM. *Steps to Follow*. Berlin, Germany: Springer-Verlag; 1990.
8. Barbeau H, Wainberg W, Finch L. Description and application of a system for locomotor rehabilitation. *Med Biol Eng Comput.* 1987;*25*:341-344. Crossref. PubMed.
9. Wade DT. *Measurement in Neurological Rehabilitation*. Oxford, England: Oxford University Press; 1992.

10. Logigian MK, Samuels MA, Falconer J, Zagar R. Clinical exercise trial for stroke patients. *Arch Phys Med Rehabil.* 1983;*64*:364-367. PubMed.

11. Dickstein R, Hochermann S, Pillar T, Schaham R. Three exercise therapy approaches. *Phys Ther.* 1986;*66*:1233-1238. Crossref. PubMed.

12. Lord JP, Hall K. Neuromuscular reeducation versus traditional programs for stroke rehabilitation. *Arch Phys Med Rehabil.* 1986;*67*:89-91. Crossref.

13. Basmajian JV, Gowlnad CA, Finlayson MAJ, Hall AL, Swanson LR, Startford PW, Trotter JE, Brandstater ME. Stroke treatment: comparison of integrated behavioral physical therapy vs. traditional physical therapy programs. *Arch Phys Med Rehabil.* 1987;*68*:267-272. PubMed.

14. Jongbloed L, Stacey S, Brighton C. Stroke rehabilitation: sensorimotor integrative treatment versus functional treatment. *Am J Occup Ther.* 1989;*43*:391-397. Crossref. PubMed.

15. Wagenaar RC, Meijer OG, Van Wieringen PCW, Kuik DJ, Hazenberg GJ, Lindenboom J, Wichers F, Rijswijk H. The functional recovery of stroke: a comparison between neurodevelopmental treatment and the Brunnstrom method. *Scand J Rehabil Med.* 1990;*22*:1-8. PubMed.

16. Friedmann PJ. Gait recovery after hemiplegic stroke. *Int Disabil Stud.* 1990;*12*:119-122. Crossref. PubMed.

17. Ozgirgin N, Bolukbasi N, Beyozova M, Orkun S. Kinematic gait analysis in hemiplegic patients. *Scand J Rehabil Med.* 1993;*25*:51-55. PubMed.

18. Perry J. *Gait Analysis, Normal and Pathological Function*. Thorofare, NJ: Slack Inc; 1992:432.

19. Grillner S. Neurobiological basis of rhythmic motor acts in vertebrates. *Science.* 1985;*228*:143-149. Crossref. PubMed.

20. Lovely RG, Gregor RJ, Roy RR, Edgerton VR. Effects of training on the recovery of full weight-bearing stepping in the adult spinal cat. *Exp Neurol.* 1986;*92*:421-435. Crossref. PubMed.

21. Eidelberg E, Walden JG, Nguyen LH. Locomotor control in macaque monkeys. *Brain.* 1981;*104*:647-663. PubMed.

22. Kottke FJ. Therapeutic exercise to develop neuromuscular coordination. In: Kottke FJ, Lehman JF, eds. *Krusen's Handbook of Physical Medicine and Rehabilitation*. 4th ed. Philadelphia, Pa: WB Saunders; 1990:452-479.

Sections

1. Abstract
2. Subjects and Methods
3. Results
4. Discussion
5. Article Information
    1. Note
    2. Affiliations
    3. Acknowledgments
6. References

LIST OF ILLUSTRATIONS

1. Figure 1
2. Figure 2
3. Figure 3

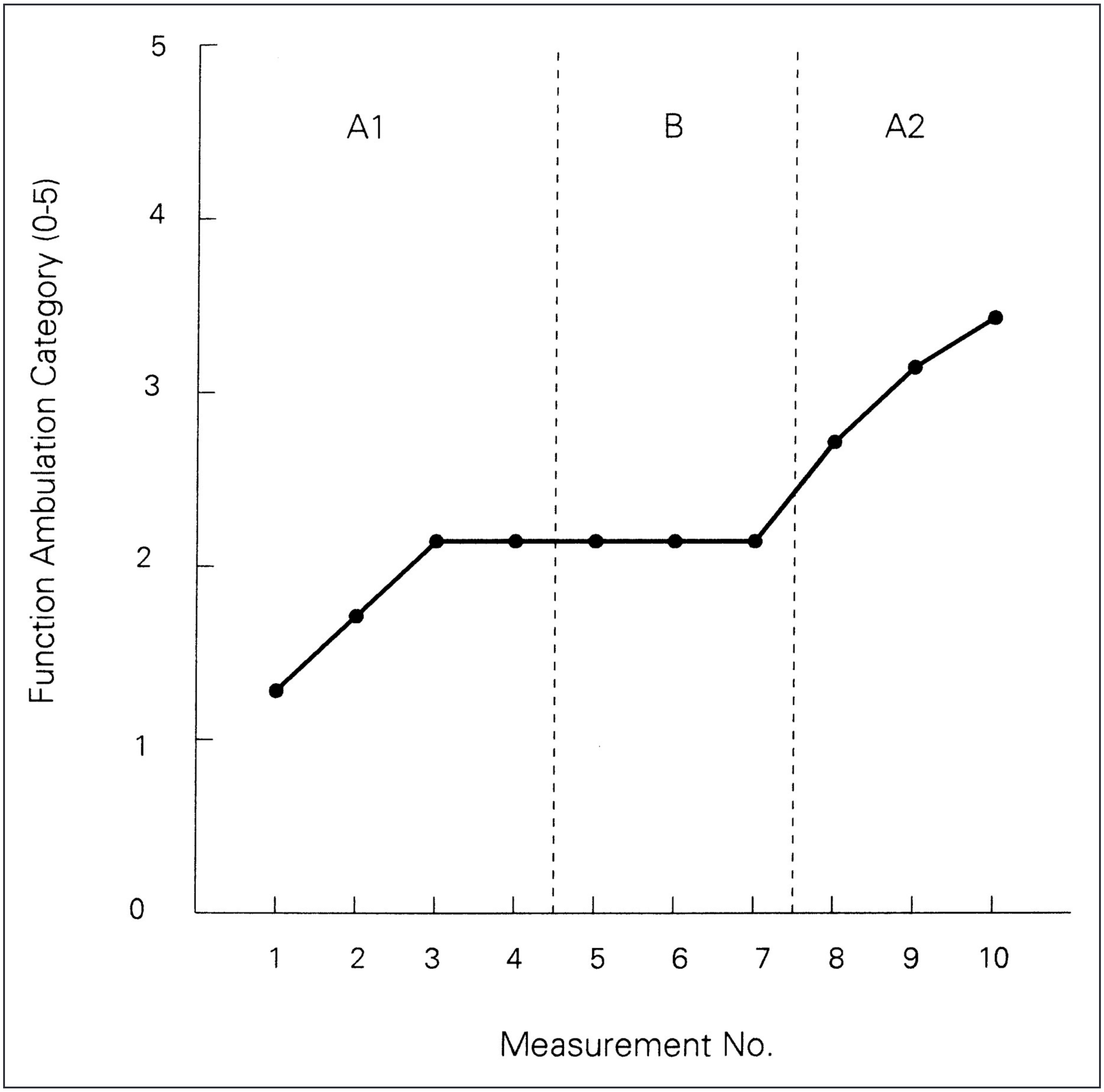

Figure 1. Line graph shows mean Functional Ambulation Category scores over time. Treadmill training applied during the A1 and A2 phases was more effective than physiotherapy applied during the B period (*P*<.05).

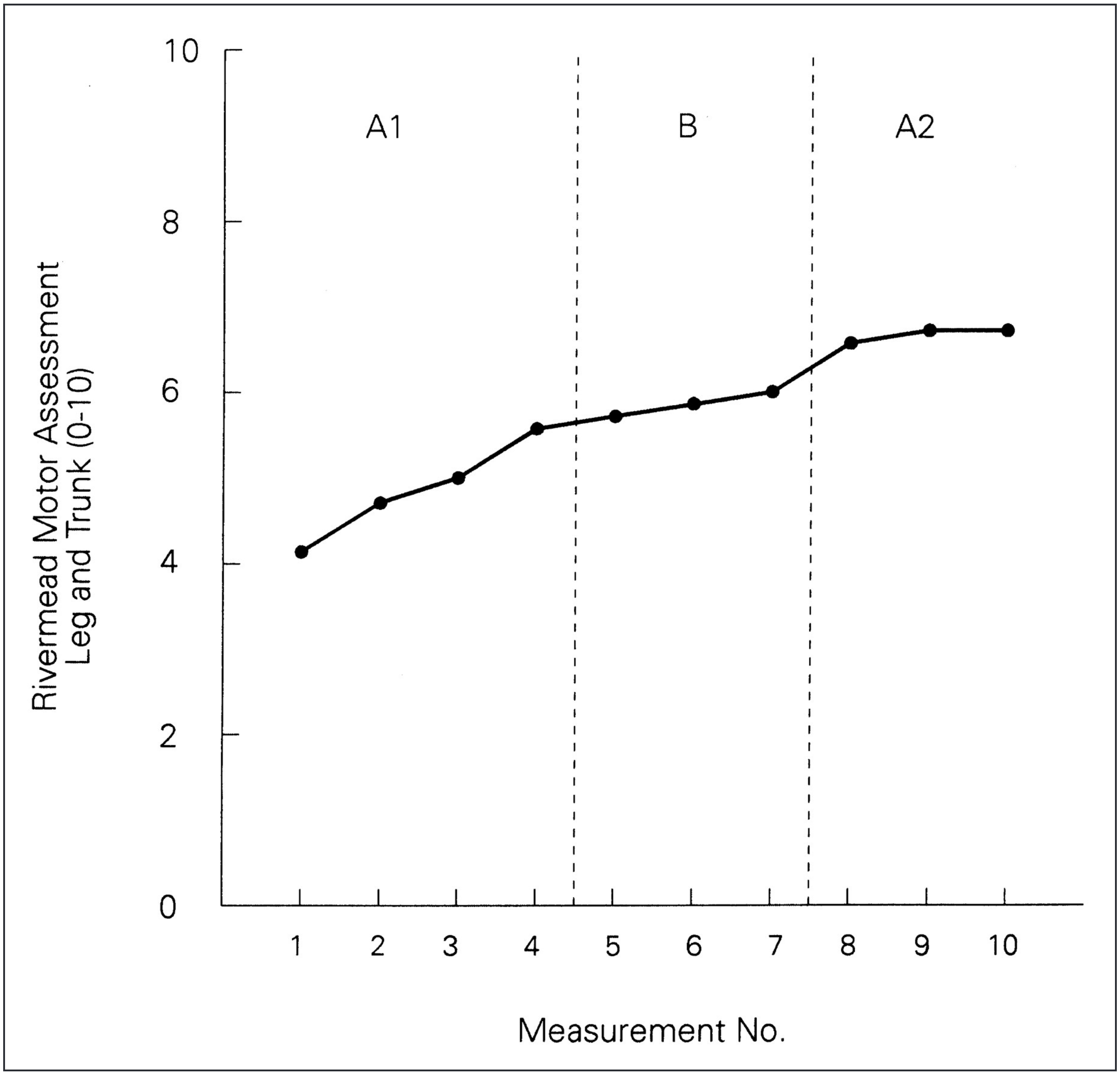

Figure 2. Line graph shows mean Rivermead Motor Assessment scores of the leg and trunk section over time. No treatment proved to be superior. A1 and A2 indicate treadmill training with partial body weight support; B, physiotherapy based on the Bobath concept.

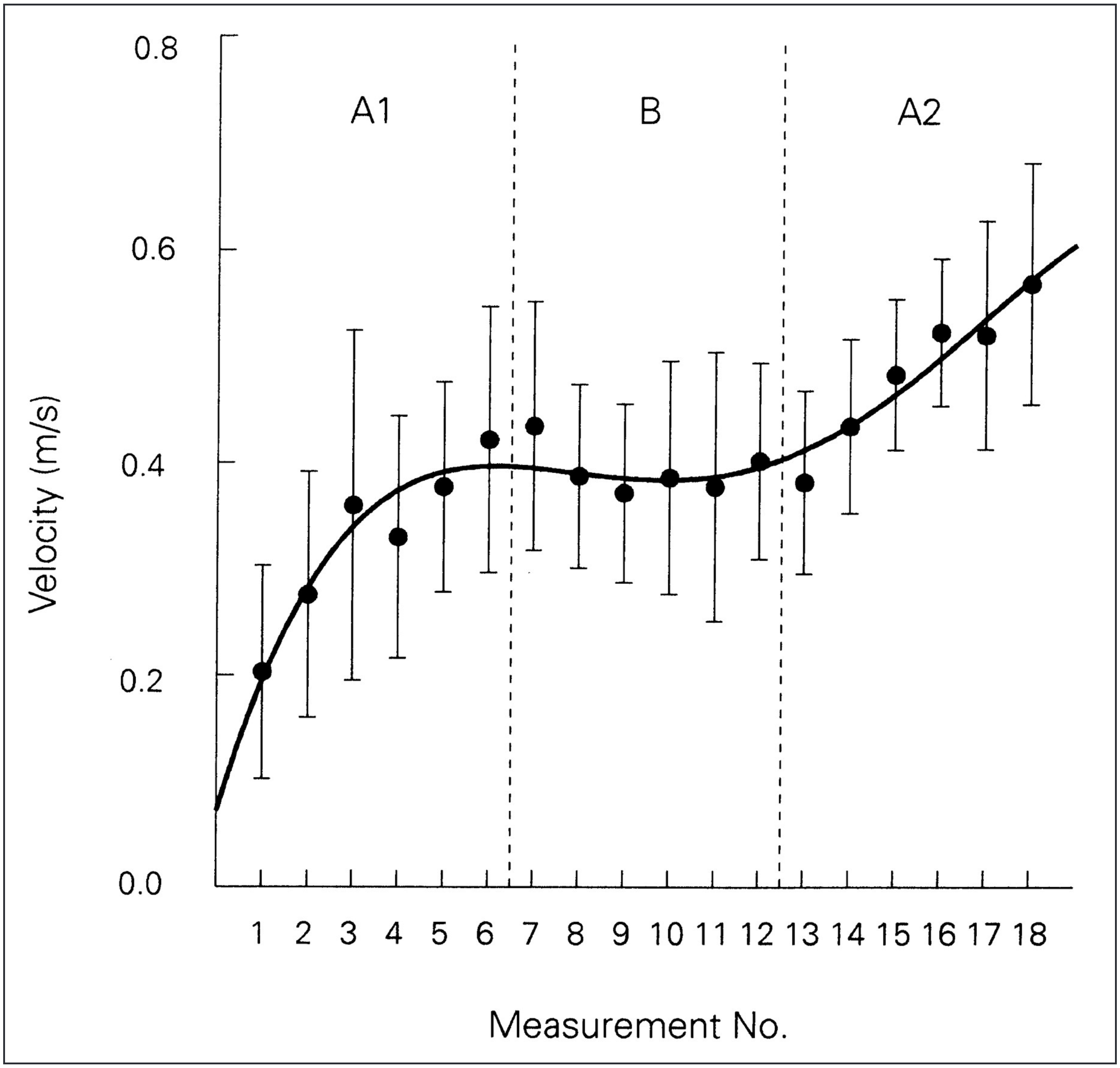

Figure 3. Line graph shows mean (±SD) walking velocity over time. Treadmill training applied during the A1 and A2 phases was more effective than physiotherapy applied during the B period (*P*<.05).

Table 1. Patient Demographics and Initial Functional Ambulation Category Scores at Time of Entry Into the Study

Pt	Age, y	Sex	Side	Etiology	Onset, d	Neglect Syndrome	Sensory Lesions	Pusher Syndrome	FAC Score
1	72	M	Right	Ischemia	91	Absent	Absent	Absent	2
2	52	M	Right	Ischemia	362	Present	Absent	Absent	2
3	54	F	Left	Ischemia	97	Present	Present	Present	1
4	64	M	Right	Ischemia	204	Present	Present	Present	0
5	71	M	Left	Ischemia	170	Absent	Present	Absent	1
6	52	M	Left	Ischemia	102	Present	Present	Absent	1
7	57	M	Left	Ischemia	215	Present	Absent	Present	0

Pt indicates patient; FAC, Functional Ambulation Category.

Table 2. Scores of Gait Ability, Motor Function, Spasticity, and Motor Strength of All Patients at Each Measuring Point

Pt	Gait Ability FAC (0-5)	Gross Function RMAG (0-13)	Leg and Trunk RMALT (0-10)	Muscle Tone, Ankle Ashworth (0-5)
1	2 2 2 2 - 2 2 2 - 2 3 3	4 5 5 5 - 5 5 5 - 5 6 7	3 3 4 6 - 6 6 6 - 6 7 8	2 1 3 1 - 1 3 2 - 1 3 2
2	3 3 3 3 - 3 3 3 - 3 4 4	5 6 7 7 - 7 7 7 - 7 7 7	4 4 4 5 - 5 5 5 - 7 7 7	4 4 4 4 - 2 3 3 - 4 3 3
3	1 1 2 2 - 2 2 2 - 3 3 4	5 5 5 5 - 5 5 7 - 7 8 9	3 4 5 6 - 7 7 7 - 7 7 7	4 3 3 4 - 4 3 4 - 3 3 3
4	0 1 1 1 - 1 1 1 - 2 2 3	5 5 5 5 - 5 5 5 - 5 6 6	3 3 3 3 - 3 4 5 - 5 5 5	4 2 2 4 - 4 3 3 - 3 3 3
5	1 2 2 2 - 2 2 2 - 2 3 3	5 5 5 5 - 6 6 6 - 6 6 6	6 8 8 8 - 8 8 8 - 8 8 8	1 1 2 1 - 3 1 1 - 2 3 2
6	1 2 3 3 - 3 3 3 - 4 4 4	5 5 6 7 - 8 9 10 - 10 10 10	6 7 8 7 - 8 8 8 - 8 8 8	4 4 4 3 - 3 3 2 - 3 4 3
7	0 1 2 2 - 2 2 2 - 2 3 3	4 4 4 4 - 4 4 5 - 5 6 6	3 3 4 3 - 3 3 3 - 4 4 4	2 2 2 2 - 2 2 2 - 2 1 1

Pt	Muscle Tone, Wrist Ashworth (0-5)	Muscle Strength, Arm MI (0-100)	Muscle Strength, Leg MI (0-100)
1	1 1 1 1 - 3 3 3 - 3 2 2	40 40 40 40 - 40 40 40 - 40 40 40	43 43 43 43 - 43 43 43 - 43 43 43
2	2 1 3 1 - 2 2 2 - 2 1 2	1 1 1 1 - 1 1 1 - 1 1 1	24 24 24 29 - 29 29 29 - 29 29 29
3	0 2 1 2 - 2 2 2 - 2 2 2	28 28 28 28 - 28 28 28 - 28 28 28	29 29 29 29 - 29 29 29 - 34 34 34
4	4 4 3 3 - 3 3 3 - 3 4 3	1 1 1 1 - 1 1 1 - 1 1 1	24 24 24 24 - 24 24 24 - 24 24 24
5	2 2 1 1 - 1 3 3 - 2 2 3	40 40 45 45 - 45 45 54 - 54 54 54	48 48 59 64 - 64 64 64 - 64 64 64
6	4 4 4 4 - 4 4 4 - 3 3 4	1 1 1 1 - 1 1 1 - 1 1 1	38 38 38 38 - 38 38 38 - 38 38 38
7	4 3 4 3 - 3 3 3 - 3 3 3	15 15 15 15 - 15 15 15 - 15 15 15	34 34 34 34 - 34 34 34 - 34 34 34

Pt indicates patient; FAC, Functional Ambulation Category; RMAG, Rivermead Motor Assessment (gross function); RMALT, Rivermead Motor Assessment (leg and trunk); Ashworth, Modified Ashworth Spasticity Scale; and MI, Motricity Index. Values are scores at the beginning of the study and at the end of each week of each phase (A1 [treadmill training with partial body weight support], B [physiotherapy based on the Bobath concept], and A2 [treadmill training with partial body weight support]).

Table 3. Gait Parameters of Each Patient and Their Mean Values at Each Measuring Point

Pt		Phase		Velocity, m/s							Cadence, steps/min							St
1		A1		0.09	0.15	0.25	0.25	0.29	0.34		40	40	52	48	62	70		0.
		B		0.36	0.34	0.35	0.45	0.33	0.40		67	73	69	76	68	73		0.
		A2		0.38	0.48	0.46	0.53	0.53	0.59		74	83	80	85	82	85		0.
2		A1		0.33	0.37	0.48	0.39	0.39	0.39		70	69	71	74	72	74		0.
		B		0.34	0.33	0.38	0.44	0.40	0.39		72	64	62	65	78	67		0.
		A2		0.35	0.40	0.44	0.48	0.50	0.49		66	62	65	70	74	72		0.
3		A1		0.31	0.37	0.37	0.44	0.40	0.39		62	67	67	81	70	74		0.
		B		0.48	0.36	0.36	0.26	0.24	0.25		71	64	62	57	51	50		0.
		A2		0.29	0.37	0.39	0.42	0.34	0.42		56	67	67	72	58	72		0.
4		A1		0.11	0.14	0.16	0.15	0.29	0.30		33	34	40	44	60	62		0.
		B		0.27	0.26	0.24	0.28	0.28	0.48		65	57	56	64	60	53		0.
		A2		0.45	0.40	0.57	0.60	0.53	0.60		68	72	83	83	82	88		0.
5		A1		0.14	0.26	0.59	0.38	0.42	0.63		41	54	85	65	65	86		0.
		B		0.59	0.50	0.50	0.50	0.40	0.33		95	84	66	87	74	70		0.
		A2		0.30	0.40	0.50	0.53	0.48	0.49		60	67	81	82	77	87		0.
6		A1		0.28	0.43	0.48	0.45	0.56	0.56		53	68	74	76	77	77		0.
		B		0.57	0.48	0.45	0.53	0.62	0.53		79	77	79	85	90	88		0.
		A2		0.53	0.59	0.56	0.59	0.69	0.77		86	95	87	90	92	92		0.
7		A1		0.16	0.21	0.19	0.25	0.29	0.33		31	40	31	48	61	58		0.
		B		0.38	0.43	0.37	0.30	0.33	0.42		58	73	69	56	58	68		0.
		A2		0.33	0.45	0.50	0.55	0.59	0.62		56	79	84	93	85	90		0.
Mean		A1		0.20	0.28	0.36	0.33	0.38	0.42		47	53	60	62	67	72		0.
		B		0.43	0.39	0.38	0.39	0.37	0.40		72	70	66	70	68	67		0.
		A2		0.38	0.44	0.49	0.53	0.52	0.57		67	75	78	82	79	84		0.

Pt indicates patient; A1 and A2, treadmill training with partial body weight support, phases 1 and 2; B, physiotherapy based on the Bobath concept.