**Table 2.** Demographic features and functional outcome and discharge disposition of patients among three subgroups

| | Subgroup A (severe; FIM ≦ 53) | | Subgroup B (moderate; 54 ≦ FIM ≦ 107) | | Subgroup C (mild; FIM ≧ 108) | |
|---|---|---|---|---|---|---|
| | SRU | GRW | SRU | GRW | SRU | GRW |
| *Demography* | | | | | | |
| Patients | 19 | 8 | 47 | 61 | 25 | 18 |
| Days after stroke (SD) | 66.2 (18.7) | 56.5 (18.0) | 59.0 (19.8) | 53.3 (19.0) | 58.8 (21.2) | 54.5 (13.3) |
| Age, years (SD) | 61.5 (13.2) | 61.4 (13.8) | 61.4 (10.6) | 60.6 (10.2) | 58.8 (11.3) | 53.1 (17.4) |
| Sex, m/f | 13/6 | 6/2 | 30/17 | 35/26 | 18/7 | 14/4 |
| Type of stroke, I/H | 10/9 | 3/5 | 27/20 | 34/27 | 17/8 | 7/11 |
| Side of stroke, r/l/both | 9/8/2 | 2/5/1 | 26/20/1 | 32/29/0 | 11/14/0 | 10/8/0 |
| *Functional status on admission* | | | | | | |
| FIM (total) on admission (SD) | 39.8 (10.0) | 44.3 (11.5) | 88.7 (14.4) | 84.9 (14.8) | 115.8 (5.9) | 118.1 (5.6) |
| FIM (motor) on admission (SD) | 27.4 (8.1) | 31.0 (8.3) | 60.8 (12.0) | 57.0 (12.8) | 82.2 (5.6) | 84.8 (5.6) |
| FIM (cognition) on admission (SD) | 12.4 (4.9) | 13.3 (5.8) | 28.0 (6.6) | 27.9 (6.1) | 33.6 (2.3) | 33.2 (3.2) |
| SIAS (motor) on admission (SD) | 5.3 (5.1) | 2.8 (2.9) | 10.9 (6.5) | 10.2 (6.1) | 17.3 (4.6) | 16.6 (5.8) |
| *Functional improvement after inpatient rehabilitation* | | | | | | |
| Increase in FIM (SD) | 26.8 (16.7) | 26.6 (24.9) | 21.9 (11.2) | 21.3 (13.5) | 4.6 (4.3) | 3.8 (3.9) |
| Increase in FIM, motor (SD) | 20.8 (12.5) | 17.0 (17.1) | 18.0 (8.8) | 18.2 (10.8) | 4.5 (3.9) | 3.2 (3.6) |
| Increase in FIM, cognition (SD) | 6.0 (7.5) | 9.6 (8.8) | 4.0 (5.0) | 3.1 (4.2) | 0.1 (1.1) | 0.6 (1.9) |
| Increase in SIAS, motor (SD) | 2.6 (3.6) | 3.0 (4.0) | 3.3 (2.9) | 4.0 (2.9) | 3.6 (3.1) | 3.7 (3.4) |
| Increase in SIAS, UE (SD) | 0.9 (1.6) | 1.1 (2.2) | 1.4 (1.7) | 1.3 (1.2) | 1.4 (1.5) | 1.5 (1.6) |
| Increase in SIAS, LE (SD) | 1.8 (2.4) | 1.9 (2.4) | 1.9 (1.8) | 2.7 (2.2) | 2.2 (1.8) | 2.2 (2.4) |
| *LOHS, discharge disposition and cost* | | | | | | |
| LOHS (SD) | 100.9 (19.5) | 93.9 (7.8) | 102.1 (14.0) | 97.8 (14.6) | 87.1 (19.8) | 87.1 (24.4) |
| Patients discharged home (%) | 9/19 (47.4)* | 0/8 (0) | 37/47 (78.7) | 45/61 (73.8) | 22/25 (88.0) | 17/18 (94.4) |
| Cost per hospital day, USD (SD) | 288 (21) | 267 (4) | 308 (168) | 275 (19) | 288 (13) | 270 (13) |

* $p < 0.001$ (vs. GRW). USD was calculated at a rate of 120 Japanese yen per USD.

(74.7% in the SRU group and 71.3% in the GRW group), LOHS and cost of hospitalization per day were also comparable between the two groups (table 1).

Next, we compared the functional outcome of patients with different degrees of initial disabilities. For patients with severe disability (subgroup A), 47.4% of patients in the SRU group were discharged home, but all patients in the GRW group were transferred to other chronic hospitals or nursing homes ($p < 0.001$, Bonferroni correction for multiple comparisons) (table 2). There was no significant difference in the increase in FIM or SIAS scores, or LOHS. There was no significant difference in the increase in FIM or SIAS scores, LOHS, or discharge disposition in patients with mild or moderate disability (subgroups B and C). There was no significant difference in the cost of hospitalization per day among three different subgroups (table 2).

## Discussion

General features of the SRU consist of multidisciplinary stroke rehabilitation effort, ADL training by nursing staff, discharge planning based on the concerted opinion of the multidisciplinary stroke rehabilitation team and regular assessment of impairment and disabilities. There are only few studies available which identified the crucial factors to determine the outcome at the SRU. Indredavik et al. [2] identified a short time interval for mobilization/training after stroke to be one of the most important factors. Since our hospital receives patients in the chronic stage after acute stroke, we cannot confirm or refute their results. They also suggested that the characteristic features of the SRU, such as specially trained staff, team rehabilitation approach, emphasis on functional training and integration of nursing care and rehabilitation were difficult to evaluate, but were the most important factor in determining the outcome in their SU model [2]. Intensive rehabilitative interventions might be beneficial as well [14]. Although various factors in the SRU, as mentioned above, might benefit stroke patients, we focused our attention on the effect of an integrated team approach through weekly interdisciplinary team conferences.

For patients with mild or moderate disability, there was no significant difference in the rate of discharge to home or in the degree of improvement in impairment and disabilities between the SRU and GRW groups. This suggests that patients with mild or moderate disability after stroke might benefit less from weekly interdisciplinary team conferences than those with severe disability, probably because they may be able to acquire the ability to live an independent life even without special instruction or intervention by the stroke rehabilitation team.

Regarding patients with severe disability after stroke, there was a significant difference in the rate of discharge to home between the two groups, even though there was no significant difference in the increase in SIAS or FIM scores, and patients in the SRU group were older and had a longer interval after the onset than those in the GRW group. This suggests that patients with severe disability required more customized preparation for discharge than those with mild or moderate disability after stroke. Patients with severe disability must remodel their houses by adding handrails to stairs, hallways, toilet and bathroom and/or by bringing in a bed for disabled and a portable toilet. They must have public and private services, such as visiting nursing service, home-helper service, utilization of institutions and doctor's visit. Their caregivers must be educated to look after special needs for ADL. They must be ready for outpatient rehabilitation. Although caregivers of patients in the GRW group also received discharged plans especially for patients who were severely disabled, it is likely that a regular team conference might provide optimal discharge planning based on the integrated up-to-date information. Thus, for those who were severely disabled, the optimized discharge planning through weekly interdisciplinary team conferences might play a crucial role in increasing the rate of discharge to home.

Our results are consistent with previous reports in the literature indicating that patients with the most severe stroke receive most benefit in a stroke unit [3], that the stroke unit improves outcomes for patients with infarcts due to large vessel diseases [15] and that independent living is determined by social factors as much as the degree of disability [16]. Cifu and Stewart et al. [17] discussed two types of rehabilitative interventions: interdisciplinary vs. multidisciplinary. The interdisciplinary approach included rehabilitation services provided by diverse professionals who communicated regularly using their various expertise to work toward a common goal, while the multidisciplinary approach usually included similar professionals, but regular communication and the common goal orientation among them were less consistent [17]. Review of the literature led them to conclude that interdisciplinary rehabilitation was strongly associated with improved functional outcome, shorter length of stay, reduced cost and decreased mortality compared with multidisciplinary rehabilitation. A recent review also suggested that an interdisciplinary team approach was better rather than pure multidisciplinary rehabilitation in geriatric rehabilitation [18]. In our study, the intervention at the SRU and GRW might correspond to interdisciplinary and multidisciplinary rehabilitation, respectively, since the major difference between the SRU and GRW was whether regular team conferences were held or not. Thus, our results provided further support for the notion that the stroke rehabilitation teamwork which was held in the SRU was one of the most important factors which determined the better disposition, particularly for those who were severely disabled.

Cost for hospitalization and LOHS were comparable between the two types of rehabilitation wards. Nevertheless, severely disabled patients who were admitted to the SRU showed a higher rate of discharge to home than those who were admitted to the GRW. Thus, it is likely that the SRU can save costs by reducing the need for long-term institutional care of those patients. Further follow-up studies are needed, however, to investigate the impact of interdisciplinary rehabilitation on the long-term outcome and cost of care of patients with stroke.

In conclusion, patients with severe disability after stroke appeared to benefit most from integrated multidisciplinary rehabilitation with regular interdisciplinary stroke team conferences in the SRU, and they had an improved discharge disposition. Our data suggest that stroke patients who are severely impaired as determined by various evaluation methods should have weekly interdisciplinary team conferences.

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*ORIGINAL ARTICLE*

# Does Therapeutic Facilitation Add to Locomotor Outcome of Body Weight–Supported Treadmill Training in Nonambulatory Patients With Stroke? A Randomized Controlled Trial

*Hajime Yagura, MD, PhD, Megumi Hatakenaka, MD, Ichiro Miyai, MD, PhD*

ABSTRACT. Yagura H, Hatakenaka M, Miyai I. Does therapeutic facilitation add to locomotor outcome of body weight–supported treadmill training in nonambulatory patients with stroke? A randomized controlled trial. Arch Phys Med Rehabil 2006;xx:xxx.

**Objective:** To assess benefit of the facilitation technique (FT) coupled with body weight–supported treadmill training (BWSTT) in nonambulatory patients with stroke.

**Design:** Randomized controlled trial.

**Setting:** Inpatient rehabilitation hospital.

**Participants:** Forty-nine patients with nonambulatory patients with stroke were randomly allocated to BWSTT coupled with the FT or mechanical assistance (control).

**Interventions:** Swinging and stance of the paretic leg were assisted using the FT or mechanically (control) during BWSTT.

**Main Outcome Measures:** The FIM instrument, Fugl-Meyer Assessment, gait speed, and cadence.

**Results:** Demographic and clinical features of the FT (n=22) and control (n=25) groups on admission were comparable after excluding 2 dropouts. There were no differences in the gains of the main outcome measures between the FT and control groups. Patients with severe impairment in the FT group had greater gains in arm function than those in the control group.

**Conclusion:** The FT did not add significantly to locomotor outcome of BWSTT in nonambulatory patients with stroke but it did require more therapists' assistance.

**Key Words:** Gait; Hemiplegia; Rehabilitation; Stroke; Treadmill test; Weight-bearing.



WHILE IT IS NOT LIKELY that patients in the chronic phase of stroke with severe hemiparesis will achieve functional use of the paretic hand, considerable gains in gait function are expected after intensive rehabilitation in these patients.[1] This suggests that locomotor function is more likely to recover than hand function in patients who failed to recover within a few months after the onset of stroke. However, evidence-based strategies for locomotor training have not been established. For instance, it remains to be determined whether body weight–supported treadmill training (BWSTT) enhances locomotor recovery after stroke.[2-12] A recent review[13] has also suggested that the effect of BWSTT on locomotor outcome of patients with stroke is not conclusive, although it is likely to be beneficial for patients with mild gait disturbance. The inconsistency of the results might be at least partially due to variations in locomotor status of patients, degree of body weight support (BWS), training speed, methods for assisting patients, and control interventions.[5-12] Although BWSTT enables even nonambulatory patients to be trained to walk, it requires additional assistance in stepping. There are at least 2 ways to provide this assistance. One is to assist the paretic foot mechanically by holding the paretic leg. The other is the facilitation technique, in which a therapist presses the hip of a patient forward and backward to ensure stable swing and stance of the paretic leg.[14] The facilitation technique (FT) induced enhanced cortical activations in multiple motor areas, including the premotor cortex, during hemiparetic gait[15] as well as improved gait performance, such as gait symmetry.[16] The afferent input from the hip joint and adequate load appear to be essential to facilitate activities in the paretic leg.[17] In healthy subjects, "unilateral walking," where they only moved the unilateral leg on the treadmill with 70% of BWS, induced muscle activities on the contralateral leg that was not moving.[17] Because such muscle activities were not seen during unilateral walking in patients with complete spinal cord injury,[17] supraspinal control might play an important role in the interlimb coordination during gait.[18,19] Cortical areas, including the supplementary motor area, premotor cortex, and sensorimotor cortex, appear to be involved in the interlimb coordination.[20] An optical imaging study revealed that the FT enhanced activations in the medial sensorimotor cortex and the premotor cortex during hemiparetic gait.[15] Increased activities in the premotor cortex are likely to be associated with improved locomotor outcome.[21] We hypothesized that using FT might be more beneficial than simply assisting the paralyzed foot mechanically during BWSTT. We focused on severe patients who had failed to reach independent gait after 4 weeks of inpatient rehabilitation and investigated whether FT improved functional outcome of BWSTT in a randomized controlled trial.

## METHODS

In a hospital with 245 beds providing approximately 3 months of inpatient rehabilitation that is fully covered by the national insurance system,[1,22] we selected patients within 3 months after the onset of stroke as possible candidates for this study. Patients were transferred to the hospital for multidisciplinary rehabilitation because they still needed assistance in

From the Neurorehabilitation Research Institute, Bobath Memorial Hospital, Osaka, Japan.

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Reprint requests to Ichiro Miyai, MD, PhD, Neurorehabilitation Research Institute, Bobath Memorial Hospital, 1-6-5, Higashinakahama, Joto-ku, Osaka, 536-0023, Japan, e-mail: *webeo@ga2.so-net.ne.jp*.

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activities of daily living (ADLs) after medical treatment coupled with a less intensive physical therapy (PT) 3 to 5 days a week in acute hospitals. Exclusion criteria included: (1) being more than 80 years old; (2) inability to understand the informed consent form because of impaired cognitive function; (3) previous stroke or dependence in ADLs prior to stroke; (4) history of myocardial infarction within 1 year; (5) uncontrolled hypertension; (6) symptomatic orthostatic hypotension; and (7) atrial fibrillation with uncontrolled rate. Next, only those who needed physical assistance for gait after 4 weeks of inpatient rehabilitation (40-min PT and occupational therapy [OT] 5d/wk and 40-min speech language pathology [SLP] therapy 5d/wk as needed) were invited to the study. We expected that additional 1-point improvement in each item of the FIM instrument[23] related to the lower-extremity function (gait, stairs, transfer ×3, bathing, toileting) by using the FT. Because the average gains ± standard deviation (SD) in total score of FIM in our institute were approximately 30±10, the standardized effect size was 7/10=0.7. Thus with $\alpha$ value of .05 and $\beta$ value of .20, the minimal sample size estimated was 52.[24] Of 863 patients hospitalized from January 2002 to December 2002, 279 patients meeting the criteria were invited to the study. We obtained written informed consent from 49 patients (fig 1). The other patients either refused to participate in this study or could not make a decision within 5 days after the proposal.

BWSTT was started at the fifth week after admission in 49 patients. BWSTT was included in the ordinary PT sessions 3 days a week for 6 weeks (weeks 5–10). Approximately half of each 40-minute PT session was used for BWSTT. The patients also received additional PT sessions without BWSTT 2 days a week and OT and SLP therapy as before during the BWSTT period. By selecting from an envelope, the participants were randomly assigned to either type of BWSTT where therapists assisted the swing and stance of the paretic leg either mechanically (control group) or by using the FT (FT group). Patients could not be blinded to the assigned intervention type. In the FT group, experienced therapists assisted flexion of the knee for the initiation of the swing phase, and prevented the pelvis from being hitched up by handling the hip and pelvis.[14] Patients with severe impairment in the FT group initially needed additional mechanical assistance both in the unaffected leg and affected leg. However, the FT group differed from the control group in that continuous sensorimotor stimulation was provided in the hip and pelvic regions during locomotor training on the treadmill. Degree of BWS provided by using the overhead harness with a pelvic belt and thigh strips attached to a suspension system[15,25,26] was optimized for each patient to walk most comfortably (0%–50%) at the beginning of each session. Treadmill speed was increased progressively as patients and assisting physical therapists could tolerate (0.2–3.0km/h). Outcome measures included Fugl-Meyer Assessment (FMA) motor scale for the upper (UE) and lower extremity (LE),[27] total FIM score, motor subscore of FIM, and gait item of FIM. These measures were assessed at the baseline on admission, 4 weeks after admission before BWSTT was started, 10 weeks when 6 weeks of BWSTT was completed, and 16 weeks after admission. Gait measures including overground gait speed for 10m, stride, and cadence were evaluated at the baseline on admission, 4 weeks after admission before BWSTT was

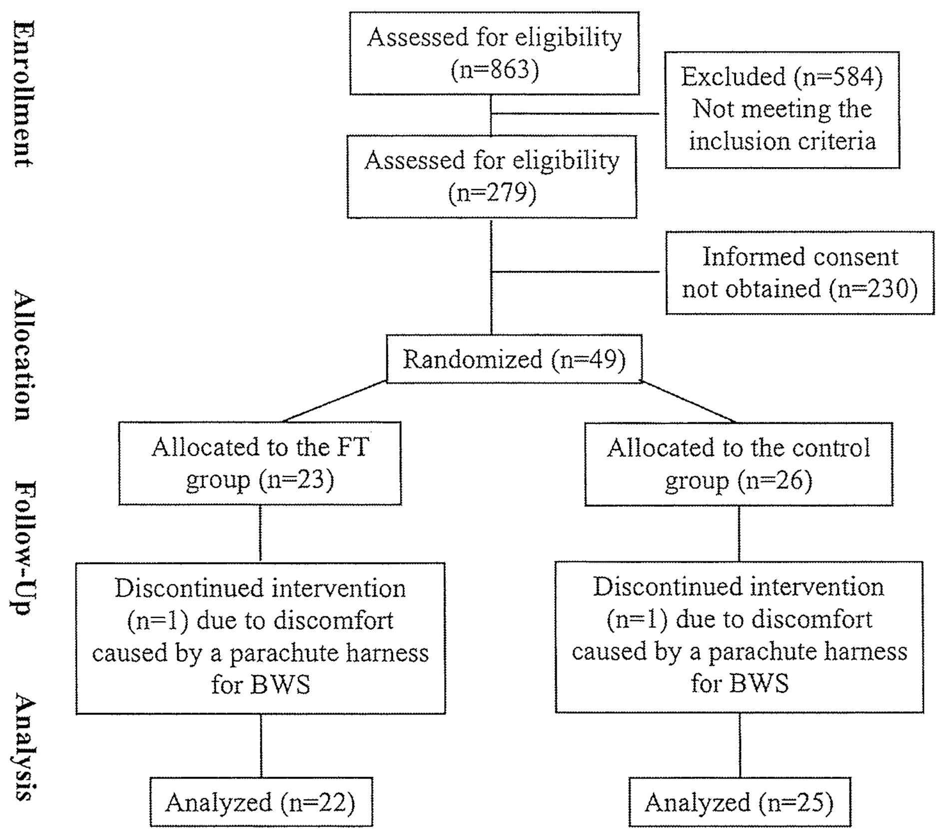


**Fig 1. Flow of patient participation.**

**Table 1: Demographic and Clinical Features of Nonambulatory Patients With Stroke**

| Features | FT | Control |
|---|---|---|
| No. of patients (n) | 22 | 25 |
| Age (y) | 62.9±7.4 | 59.3±5.7 |
| Sex (male/female), n | 16/6 | 19/6 |
| Type of stroke (CI/CH) | 9/13 | 10/15 |
| Paretic side (R/L) | 8/14 | 14/11 |
| Site of lesion (Ctx/Sub/Com/brainstem) | 2/17/1/2* | 1/22/0/2 |
| Days after the onset on admission | 57.0±11.0 | 58.4±24.4 |
| MMSE score | 22.9±8.0 | 22.2±7.6 |
| FMA UE score (range, 0–66) | 12.1±10.2 | 16.2±17.3 |
| FMA LE score (range, 0–34) | 11.9±5.4 | 15.0±5.4 |
| FIM score (range, 18–126) | 65.5±20.9 | 73.3±17.3 |
| FIM motor score (range, 13–91) | 41.7±13.7 | 47.7±11.7 |
| FIM gait score (range, 1–7) | 1.6±0.9 | 2.0±1.0 |
| Hospital length of stay (d) | 110.3±15.0 | 107.6±17.8 |

NOTE. Values are mean ± SD unless otherwise indicated.
Abbreviations: CH, cerebral hemorrhage; CI, cerebral infarct; Com, combined cortical and subcortical lesion; Ctx, cortical lesion; L, left; MMSE, Mini-Mental State Examination; R, right; Sub, subcortical lesion.
*Three patients with cortical lesion in the FT group had damage in the premotor cortex.

started, every 2 weeks during the BWSTT, and in follow-up periods up to 16 weeks by therapists who were not blinded to the allocation. Gait speed in nonambulatory patients even with assistance was rated as 0m/s. Stride and cadence could not be measured in such patients. This study was approved by the local ethics committee.

For statistical analyses of demographic data in the 2 groups (FT vs control), we used the chi-square test or Mann-Whitney test. To compare the outcome measures of the 2 groups, we used 2-factor repeated-measures analysis of variance (ANOVA). Post hoc test was adjusted for multiple comparisons using a Bonferroni adjustment. We also used Cox proportional hazards analyses whether the group allocation might predict the possibility of reaching independent gait indoor and gait with supervision or light contact guard. Statistical significance was set at $P$ less than .05.

## RESULTS

Of 49 patients, 23 patients were allocated to the FT group and 26 to the control group. BWSTT was discontinued at the first session in 2 patients (1 FT, 1 control). The main reason for the dropout was discomfort caused by a parachute harness during BWS. Otherwise there were no adverse effects associated with BWSTT. Further analyses were performed in 47 patients (FT=22, control=25). Demographic and clinical features of the patients on admission are comparable (table 1). Lesions were mainly located in the subcortical areas involving the internal capsule and basal ganglia. Three patients in the FT group had the premotor lesions. During 6 weeks of BWSTT, the degree of BWS and treadmill speed did not differ significantly between the groups (table 2). The FT group needed significantly more therapists than the control group ($P<.003$), although there was no interaction between group and time ($F_{6,44}=1.3$, $P=.25$). This might reflect that severely disabled patients tended to need mechanical assistance of the paretic leg in addition to the FT. The rate of recovery as measured by weekly gains in total FIM score was greater in the baseline period (2.9±2.6/wk) than in the BWSTT period (1.8±1.5, $P<.05$), probably due to the common nature of recovery curve after stroke. Figure 2 shows serial changes of the outcome measures. Repeated-measures ANOVA for total FIM score revealed significant main effects for group ($F_{1,45}=4.1$, $P<.05$) and for time ($F_{3,135}=105.4$, $P<.001$), without significant interaction. This indicates that general disability in the control group was significantly less severe than in the FT group and that there was a relative failure of the randomization to balance the 2 groups on the main outcome measures. Mean changes ± SD of total FIM score per week in the FT and control groups were 1.7±0.9 and 1.9±1.2, respectively (not significant [NS]). Only main effect for time, but not for group, was significant for motor FIM score ($F_{3,135}=49.8$, $P<.001$) and gait speed ($F_{7,233}=32.4$, $P<.001$). Mean changes ± SD of motor FIM score per week in the FT and control group were 1.2±1.0 and 1.3±1.2, respectively (NS). Because stride and cadence were not measured in patients who remained nonambulatory, these parameters were not included in statistical analysis. Similarly, in FM scores for the UE and LE, there were no group differences although both groups equally improved during the study period (UE: $F_{3,135}=38.8$, $P<.001$; LE: $F_{3,135}=54.3$, $P<.001$).

Next, we divided the patients into 2 subgroups based on the locomotor status as measured by the gait item of FIM (FIM gait) on admission. In patients with severe gait disorder (FIM gait score, 1; n=22), improvement of FIM, FIM gait, gait speed, and FMA score for the LE were comparable between the FT and control group. However, improvement of FM score for the UE was greater in the FT group (n=13) than the control group (n=9), as indicated by significant interaction between group and time ($F_{3,60}=3.3$, $P<.05$) as well as a significant main effect for time ($F_{3,135}=24.8$, $P<.001$) but not for group (fig 3). In patients with mild to moderate gait disorder (FIM gait range, 2–4; n=25), improvement of all these parameters was comparable.

**Table 2: Interventions During the BWSTT Period in Each Group**

| Group | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 |
|---|---|---|---|---|---|---|
| Degree of BWS (%) | | | | | | |
| FT | 12.0±5.9 | 8.5±6.6 | 6.9±6.7 | 5.4±6.1 | 5.6±7.1 | 5.1±6.7 |
| Control | 10.2±10.5 | 8.6±9.6 | 7.5±10.8 | 5.0±8.5 | 4.0±8.7 | 3.0±8.4 |
| Treadmill speed (km/h) | | | | | | |
| FT | 0.61±0.33 | 0.73±0.34 | 0.85±0.30 | 0.96±0.36 | 1.0±0.35 | 1.1±0.36 |
| Control | 0.77±0.30 | 0.91±0.30 | 0.96±0.32 | 1.1±0.30 | 1.1±0.30 | 1.1±0.40 |
| No. of therapists needed for assistance | | | | | | |
| FT | 1.9±0.75 | 1.8±0.61 | 1.6±0.60 | 1.6±0.58 | 1.6±0.73 | 1.6±0.66 |
| Control | 1.1±0.68 | 1.2±0.87 | 1.1±0.66 | 1.0±0.66 | 1.0±0.66 | 0.8±0.6 |

NOTE. Values are mean ± SD.

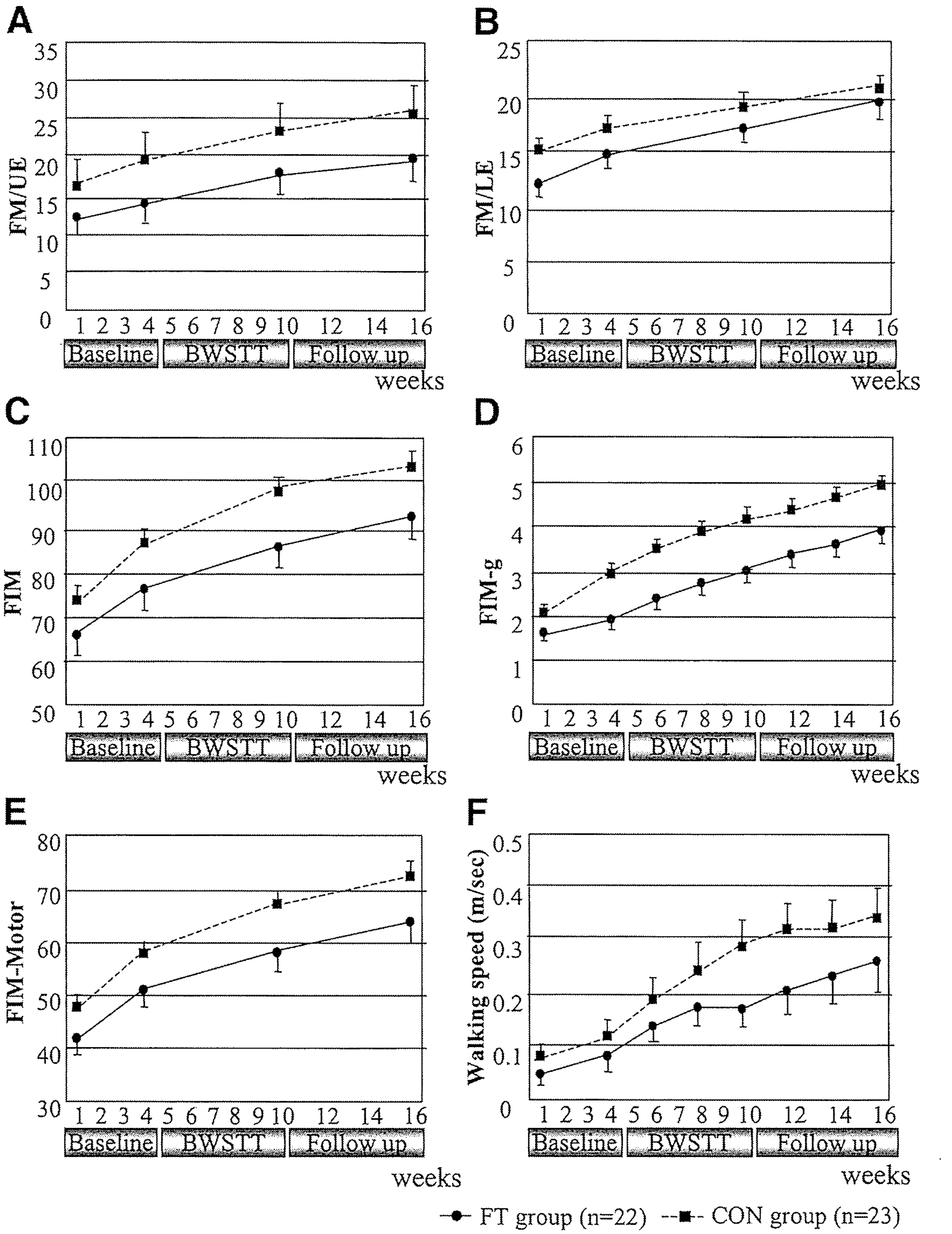


Fig 2. Changes of the outcome measures in the FT (facilitation technique) and control groups (n=47). Improvement of (A) FMA UE scores, (B) FMA LE scores, (C) total FIM scores, (D) FIM gait scores, (E) motor FIM scores, and (F) gait speed were comparable. Values are mean ± standard error (SE) (error bars). Abbreviations: FIM-g, FIM gait score; FM, Fugl-Meyer Assessment; UE, upper extremity; LE, lower extremity.

Finally, to compare real-world outcome of locomotor function, we performed Cox proportional hazards analyses with adjustment of age and using the baseline locomotor status (FIM gait score on admission and week 4) as covariates. Reaching independent gait indoor (FIM gait score, 6 or 7) was not associated with group (hazard ratio [HR], .53; 95% confidence

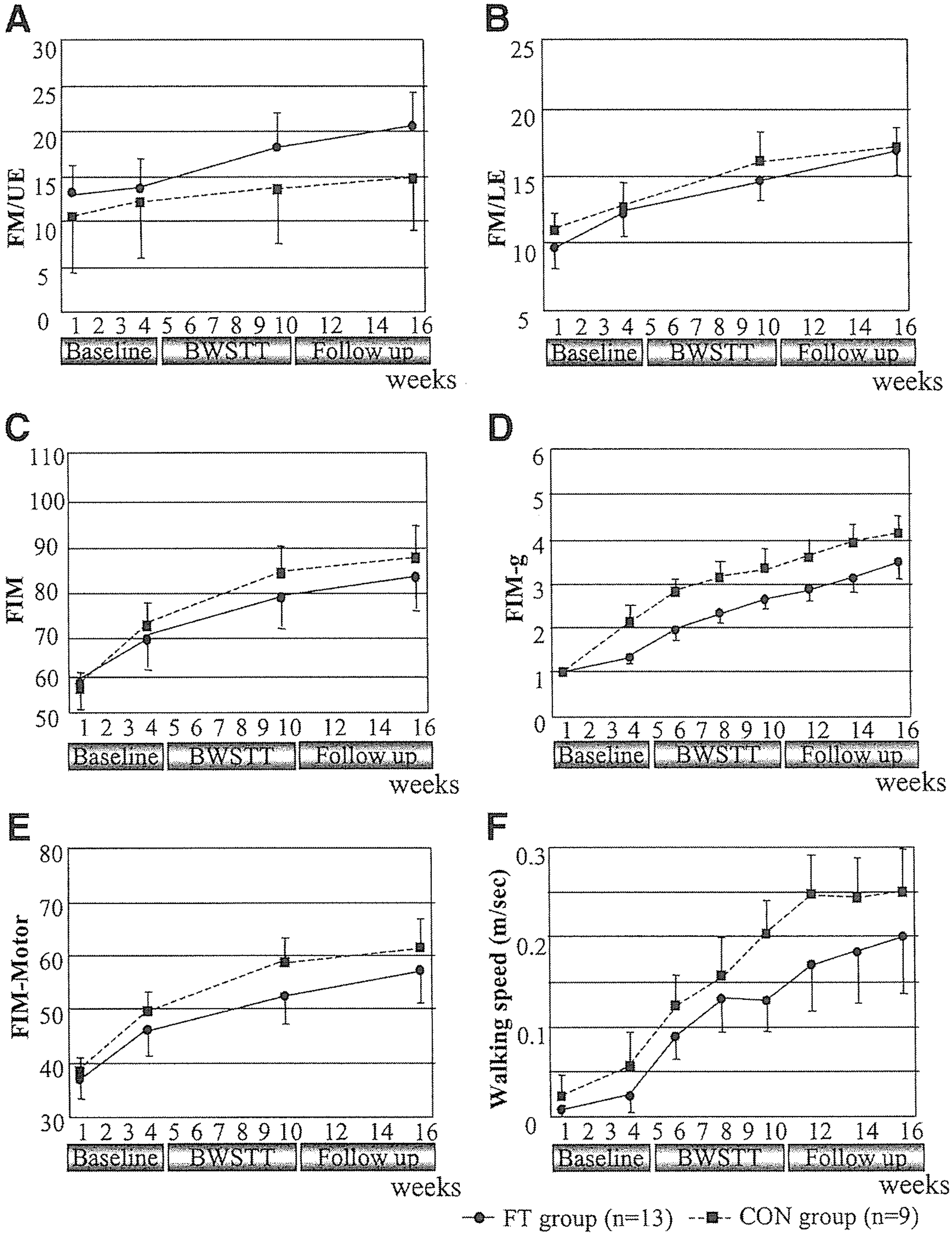


Fig 3. Changes of the outcome measures in patients with severe gait disorder (FIM gait score, 1 on admission, n=22). An ANOVA indicated that improvement of (A) FMA UE scores was significantly better in the FT (facilitation technique) group than the control group. (B) Improvement of FMA LE scores, (C) total FIM scores, (D) FIM gait scores, (E) FIM motor scores, and (F) gait speed were comparable. Values are mean ± SE (error bars). Abbreviations: FIM-g, FIM gait score; FM, Fugl-Meyer Assessment; UE, upper extremity; LE, lower extremity.

interval [CI], 0.12–2.25) or the baseline locomotor status. Reaching gait with supervision (FIM gait score, 5) was not associated with group (HR=.83; 95% CI, 0.37–1.85), but was associated with the locomotor status (FIM gait) at 4 weeks before BWSTT was started (HR=1.73; 95% CI, 1.07–2.79; $P<.05$).

## DISCUSSION

We hypothesized that using the FT might be more beneficial than simply assisting the paretic leg during BWSTT to nonambulatory patients with stroke. However, we failed to show the benefit of the FT coupled with BWSTT to patients with stroke presenting with severe gait disorder. There might be several reasons for the failure. Number of studied patients might be small. However, this is unlikely because number of recruited patients was close enough to the estimated sample size. The plotted figures also support that increasing sample size would not change our statistical findings. Second, the control group showed less severe impairment and disability on admission and greater improvement during the baseline period before BWSTT was started compared with the FT group. Third, the damage in the descending motor pathways and the basal ganglia causing severe hemiparesis could have diminished the effect of the FT in our patients.[28] Fourth, the settings of treadmill speed in our study appear to be slower than those in the previous literature.[4,5,9,12] However, this is unlikely because we studied patients with most severe gait disorder who were nonambulatory even after 4-week inpatient rehabilitation and indeed we tried the highest speed that patients could tolerate. Finally, more patients in the FT group had the premotor lesion that might have altered locomotor outcome.[29]

Interestingly, patients with the most severe gait disorder in the FT group showed significantly greater improvement of the UE function than those in the control group. One of the adverse effects of BWS is inducing associated movements of the affected UE in an effort to adapt oneself to the unusual condition of BWS.[30] We indeed observed that associated movements were less frequent in the FT group than in the control group, although this phenomenon was not evaluated quantitatively. Because the interlimb coordination of the legs and arms, such as arm swing during gait, is mediated by the propriospinal neurons,[31] it might be possible that afferent input induced by the hip manipulation might reduce associated movements of the affected UE via these neurons. Enhanced cortical activation in the motor related areas induced by the FT[15] might also be associated with greater improvement of the affected UE. To clarify whether such improvement of the UE function in patients with severe gait disorder is clinically relevant, further studies are needed.

## CONCLUSIONS

The FT did not add significantly to locomotor outcome of BWSTT in nonambulatory patients with stroke, while requiring more therapists' assistance. Further studies are needed to determine whether the greater improvement in FM scores of the UE in the FT group is clinically relevant.

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