CHAPTER IV

RESULTS

1. Participant characteristics

Twenty two patients were volunteered to the study. Two patients were excluded after a few weeks of intervention because they could not follow the study protocol. One patient moved to the other province and the other could not keep in contact. Twenty patients were randomly assigned to two different sequences of intervention, that is, group A: TSE followed by ES+TSE (TSE/ ES+TSE) and group B: ES+TSE followed by TSE (ES+TSE/ TSE). Most of patients completed the training programs except for one patient in group B who dropped out due to complication from diabetic retinopathy a few days prior to the completion of the 8-week program. Thus, the number of patients in the last assessment of group B was equal to nine.

The participants' demographics details are presented in Table 1. All participants demographics data were not significantly different when compared between group A and B, except gender. Age range of group A and B were 32 to 61 years (mean±standard deviation (SD) = 50.5±8.0 years) and 21 to 58 years (mean±SD = 48.6±11.0 years), respectively. The mean time since hemiplegic onset of group A and B were 26.9±19.6 months and 27.3±34.6 months, respectively (Table 1).

Table 1 The participants' demographics data

Participant characteristics	Group A: TSE/ ES+TSE	Group B: ES+TSE/ TSE	P-values
Age (year) (range)	50.5±8.0 (32-61)	50.8±11.3 (21-62)	0.970
Male/Female	9M/1F	4M/6F	0.004*
Weight (kg), mean±SD	61.6±6.8 (47.6-68.5)	55.7±5.0 (47-63.8)	0.138
Height (cm), mean±SD	164.6±5.7 (156-170)	158.7±9.3 (146.5-173)	0.322
Time post stroke (mo), mean±SD	26.9±19.6 (2-84)	29.7±33.6 (4-120)	0.159
Afftected side (Right:R/Left:L)	6R/4L	6R/4L	
Pathology	3 Inf/7 Hemor	3 Inf/1 Infec/ 6 Hemor	
Spasticity of biceps, median (min-max)	1 (1-2)	1 (0-2)	0.302
Spasticity of triceps, median (min-max)	0 (0-2)	1 (0-2)	0.969
MAS-UA, median (min-max)	2 (1-6)	3 (1-6)	0.969
MAS-H, median (min-max)	0 (0-5)	0 (0-5)	0.764
Sensation (Imp/Int)	4 Imp/6 Int	1 Imp/9 Int	
BI, mean (min-max)	98 (90-100)	96.5 (85-100)	0.194
TMMSE, mean (min-max)	26.1 (24-28)	26.3 (24-29)	0.322

*$P<0.05$; between group comparison using the Mann-Whitney U test.

MAS-UA= upper arm function of Motor Assessment Scale, MAS-H= hand movements of Motor Assessment Scale, TMMSE=Thai Mini Mental Status Examination, BI=Barthel index, Imp=impaired, Int=intact, Inf=infarction, Infec=infection, Hemor=Hemorrhage, SD=standard deviation, min=minimum, max=maximum, mo=month

Table 2 Comparison of duration of home-based training (the first 4-week and the second 4-week) in each group

Duration of training	1st 4-week (hr)	Average (hr/week) mean±SE (min-max)	2nd 4-week (hr)	Average (hr/week) mean±SE (min-max)	P-values
Group A: TSE/ ES+TSE	31.7	7.9±0.6 (7.4-8.7)	40	10.0±0.6 (9.4-10.8)	0.068
Group B: ES+TSE/ TSE	24.6	6.2±0.8 (4.9-6.7)	23.8	6.0±0.2 (5.8-6.3)	0.713

*P<0.05; within group comparison using the Wilcoxon Signed Ranks test

Comparison of duration of training between the first and the second 4-week was not significantly different in both groups (Table 2). All participants could follow the research protocol. The hours of training was ranged from 7.4-10.8 hours/week in group A and 4.9-6.7 hours/week in group B.

2 Baseline data

Comparison of baseline outcome parameters prior to the treatment showed no difference within group (Table 3). Between group comparison also showed no difference except AROM of the elbow flexion in baseline 1 of group B which was more than group A (*P*=0.045) (Table 4). Baseline 2 data were used to compared with other assessments at week 5th and 9th.

Table 3 Comparison within group of baseline data prior to the treatment

Outcome parameters	Group A TSE/ ES+TSE			Group B ES+TSE/ TSE		
	Baseline 1 (mean±SE)	Baseline 2 (mean±SE)	P-values	Baseline 1 (mean±SE)	Baseline 2 (mean±SE)	P-values
mWMFT						
mWMFT-sec	1073.0±152.0	1006.0±153.7	0.114	862.3±189.0	864.2±192.4	0.859
mWMFT-FA	27.7±2.8	28.4±3.1	0.182	32.0±5.7	32.0±5.7	0.735
MAS, mean (min-max)						
MAS-UA	2 (1-6)	2 (1-6)	1.000	3 (1-6)	3 (1-6)	1.000
MAS-H	0 (0-5)	0 (0-5)	1.000	0 (0-5)	0 (0-5)	0.317
AROM (degree)						
Shoulder abduction	101.1±16.7	102.3±16.3	0.135	113.0±17.3	113.1±17.2	0.136
Elbow flexion	113.1±9.3	113.9±9.1	0.113	119.7±13.8	120.5±13.9	0.526
Elbow extension	156.3±11.6	155.4±12.1	0.241	146.0±18.1	145.8±18.2	0.255
Wrist flexion	8.8±4.7	8.3±4.3	0.588	19.3±6.8	19.0±7.3	0.883
Wrist extension	17.7±6.6	18.3±6.9	0.416	27.7±9.4	28.4±9.6	0.416
PROM (degree)						
Shoulder flexion	155.0±4.9	157.0±4.5	0.139	158.2±5.5	158.3±5.6	0.888
Shoulder abduction	166.9±4.1	166.5±4.6	1.000	170.0±3.1	170.6±3.1	0.753
Elbow flexion	143.5±1.5	144.1±1.5	0.406	148.1±1.5	146.7±1.8	0.272
Elbow extension	177.9±2.1	178.3±1.8	0.174	180.0±0.0	180.0±0.0	1.000
Wrist flexion	84.3±2.0	86.2±1.7	0.108	84.5±1.9	83.7±2.2	0.059
Wrist extension	83.5±1.3	85.5±1.1	0.083	82.5±3.6	82.4±4.8	0.888
modified Ashworth scale, median (min-max)						
Biceps brachii	1 (0-2)	1 (0-2)	1.000	1 (0-2)	1 (0-2)	0.157
Triceps brachii	0 (0-2)	0 (0-2)	0.317	1 (0-2)	1 (0-2)	0.157
Wrist flexors	2 (1-2)	2 (0-2)	0.206	1.5 (0-2)	1 (0-2)	0.083
Wrist extensors	0 (0-1)	0 (0-0)	0.055	0 (0-1)	0 (0-1)	1.000

*P<0.05; within group comparison using the Wilcoxon Signed Ranks test

AROM=active range of motion, PROM=passive range of motion, mWMFT-sec=modified Wolf Motor Function Test of time, mWMFT-FA=functional ability of modified Wolf Motor Function Test, MAS= Motor Assessment Scale, MAS-UA= upper arm function of Motor Assessment Scale, MAS-H= hand movements of Motor Assessment Scale, min=minimum, max=maximum.

Table 4 Comparison between groups of baseline data prior to the treatments

Outcome parameters	Group A TSE/ ES+TSE Baseline 1 (mean±SE)	Group B ES+TSE/ TSE Baseline 1 (mean±SE)	P-value	Group A TSE/ ES+TSE Baseline 2 (mean±SE)	Group B ES+TSE/ TSE Baseline 2 (mean±SE)	P-values
mWMFT						
mWMFT-sec	1073.0±152.0	862.3±189.0	0.326	1006.0±153.7	864.2±192.4	0.290
mWMFT-FA	27.7±2.8	32.0±5.7	0.405	28.4±3.1	32.0±5.7	0.472
MAS, mean (min-max)						
MAS-UA	2 (1-6)	3 (1-6)	0.584	2 (1-6)	3 (1-6)	0.584
MAS-H	0 (0-5)	0 (0-5)	0.584	0 (0-5)	0 (0-5)	0.550
AROM (degree)						
Shoulder abduction	101.1±16.7	113.0±17.3	0.597	102.3±16.3	113.1±17.2	0.597
Elbow flexion	113.1±9.3	119.7±13.8	0.161	113.9±9.1	120.5±13.9	0.131
Elbow extension	156.3±11.6	146.0±18.1	0.725	155.4±12.1	145.8±18.2	0.785
Wrist flexion	8.8±4.7	19.3±6.8	0.267	8.3±4.3	19.0±7.3	0.342
Wrist extension	17.7±6.6	27.7±9.4	0.526	18.3±6.9	28.4±9.6	0.579
PROM (degree)						
Shoulder flexion	155.0±4.9	158.2±5.5	0.545	157.0±4.5	158.3±5.6	0.850
Shoulder abduction	166.9±4.1	170.0±3.1	0.595	166.5±4.6	170.6±3.1	0.362
Elbow flexion	143.5±1.5	148.1±1.5	0.045*	144.1±1.5	146.7±1.8	0.288
Elbow extension	177.9±2.1	180.0±0.0	0.317	178.3±1.8	180.0±0.0	0.317
Wrist flexion	84.3±2.0	84.5±1.9	0.879	86.2±1.7	83.7±2.2	0.271
Wrist extension	83.5±1.3	82.5±3.6	0.405	85.5±1.1	82.4±4.8	0.649
modified Ashworth scale median (min-max)						
Elbow flexors	1 (0-2)	1 (0-2)	0.564	1 (0-2)	1 (0-2)	0.218
Elbow extensors	0 (0-2)	1 (0-2)	0.118	0 (0-2)	1 (0-2)	0.411
Wrist flexors	2 (1-2)	1.5 (0-2)	0.235	2 (0-2)	1 (0-2)	0.411
Wrist extensors	0 (0-1)	0 (0-1)	0.342	0 (0-0)	0 (0-1)	0.146

*P<0.05; between group comparison using the Mann-Whitney U test

AROM=active range of motion, PROM=passive range of motion, mWMFT-sec=modified Wolf Motor Function Test of time, mWMFT-FA=functional ability of modified Wolf Motor Function Test, MAS= Motor Assessment Scale, MAS-UA= upper arm function of Motor Assessment Scale, MAS-H= hand movements of Motor Assessment Scale, min=minimum, max=maximum

3 Comparison between two treatments

To eliminate carrying over effect of the first 4-week treatment, the differences in all outcome parameters which were obtained by subtracting pre-treatment scores from the 4-week scores were determined. Data of the same treatment were grouped, that is, TSE and ES+TSE. Thus, the effects of each treatment were determined from 20 participants and were compared using the Wilcoxon Signed Ranks test. Results showed that mWMFT in both time and functional ability elements were superior in ES+TSE to TSE group (Table 5). As for AROM, shoulder abduction; and wrist flexion and extension were higher in ES+TSE compared to TSE alone whereas PROM and MAS were not changed. The modified Ashworth scale showed a slight but significant decrease in wrist flexor spasticity in ES+TSE treatment. Thus, home-based electrical stimulation combined with task-specific exercise has a superior effect to task-specific exercise alone on motor functions.

4 Within group comparisons

4.1 modified Wolf motor function test (mWMFT)

To determine effects of ES+TSE and TSE on temporal changes (week 1st, 5th and 9th) of motor functions, repeated measures analysis was evaluated using the Friedman test and the Wilcoxon Signed Ranks test was set as the post hoc test. Significantly, mWMFT-sec markedly decreased after 4-week of ES+TSE in both groups (week 5th vs 9th in group A, and week 1st vs 5th in group B) (Table 6). Moreover, mWMFT-FA also showed significant improvement in similar to mWMFT-sec. In contrast to the effects of ES+TSE, TSE did not demonstrate significant change of mWMFT after 4-week training in both groups. However, all participants could significantly improve

the mWMFT after completion of the 8-week program. Thus, combined home-based electrical simulation and task-specific exercise could improve motor functions after 4-week training regardless of the order of intervention.

Table 5 Mean differences of outcome parameters between task-specific exercise (TSE) and electrical stimulation combined with task-specific exercise (ES+TSE) (n=20)

Outcome parameters	Mean difference		P-values
	TSE (n=20)	ES+TSE (n=20)	
mWMFT			
mWMFT-sec	-17.7±21.6	-116.1±28.6	0.025*
mWMFT-FA	1.9±0.8	4.0±0.7	0.049*
AROM (degree)			
Shoulder abduction	4.1±4.2	11.6±3.1	0.049*
Elbow flexion	4.5±1.9	2.8±1.3	0.601
Elbow extension	3.7±2.6	4.8±2.7	0.444
Wrist flexion	1.9±1.4	11.3±3.1	0.035*
Wrist extension	3.0±2.2	11.1±2.6	0.015*
PROM (degree)			
Shoulder flexion	5.1±1.3	7.2±2.3	0.862
Shoulder abduction	2.2±1.2	4.8±1.4	0.232
Elbow flexion	1.4±0.8	1.4±0.7	0.727
Elbow extension	0.8±0.8	0.2±0.2	0.317
Wrist flexion	2.8±1.1	2.3±0.6	0.983
Wrist extension	2.1±0.8	2.2±0.6	0.614
Motor Assessment Scale			
MAS-UA	0 (0-1)	0 (0-2)	1.000
MAS-H	0 (0-1)	0 (0-2)	0.157
modified Ashworth scale			
Biceps brachii	0 (-1-1)	0 (-1-1)	0.158
Triceps brachii	0 (-2-2)	0 (-2-0)	0.299
Wrist flexors	0 (0-2)	-0.5 (-2-0)	0.003*
Wrist extensors	0 (-1-0)	0 (-1-0)	0.564

*P<0.05; between group comparison using the Wilcoxon Signed Ranks test

Table 6 Comparison of mWMFT at week 1st, 5th and 9th in each group

mWMFT	Week 1st (mean±SE)	Week 5th (mean±SE)	Week 9th (mean±SE)	*P*-values		
				Week 1st vs 5th	Week 5th vs 9th	Week 1st vs 9th
Group A: TSE/ ES+TSE						
mWMFT-sec	1006.0±153.7[a]	968.9±156.5[a]	857.5±156.3[b]	0.203	0.015*	0.005*
mWMFT-FA	28.4±3.1[a]	31.0±3.7[a]	34.5±4.4[b]	0.063	0.012*	0.012*
Group B: ES+TSE/ TSE						
mWMFT-sec	864.2±192.4[a]	743.3±189.4[b]	810.8±207.8[b]	0.011*	0.484	0.012*
mWMFT-FA	32.0±5.7[a]	36.4±6.3[b]	35.0±6.8[b]	0.005**	0.249	0.008**

*P<0.05; ** P<0.01; within group comparison using the Wilcoxon Signed Ranks test
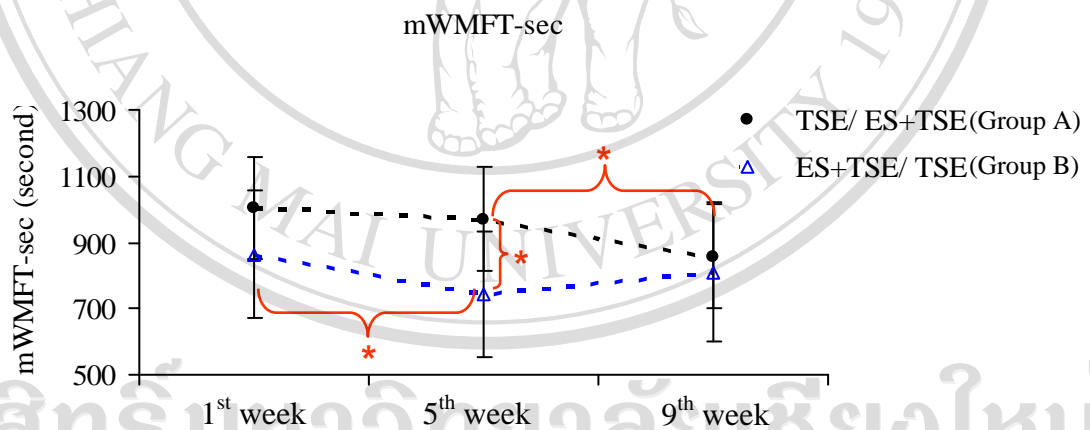
Figure 3 Comparison of mWMFT-sec at week 1st, 5th and 9th in each group
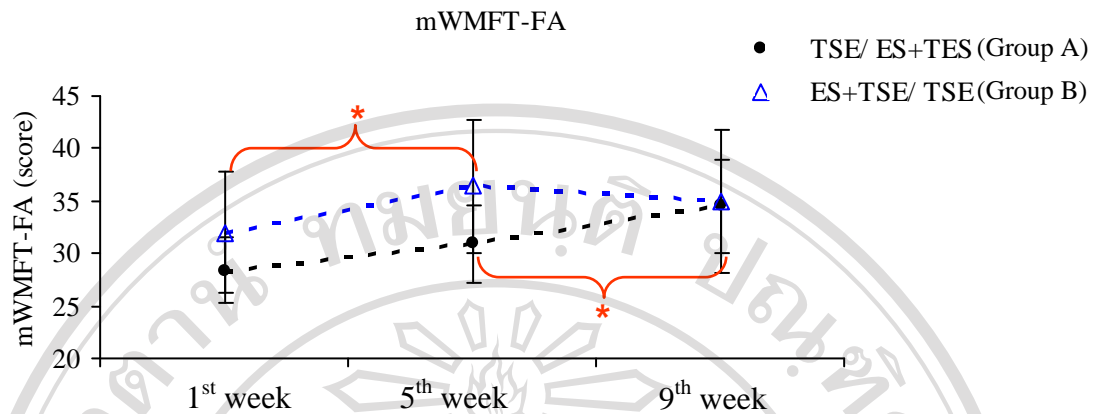
mWMFT-FA

Figure 4 Comparison of mWMFT-FA at week 1st, 5th and 9th in each group

Figure 3 and 4 show the same data as presented in Table 9. Both types of treatment (TSE vs ES+TSE) improved in mWMFT but only the ES+TSE demonstrated significant change. The effects of ES+TSE did not depend on the sequence of intervention. However, performance of mWMFT in group B tended to reverse (not significant) after cessation of the stimulation period. Furthermore, group B showed better performance than group A but only reached statistically significant at the 5th week in movement time of mWMFT.

4.2 Motor Assessment Scale (MAS)

To investigate effects of TSE and ES+TSE on motor functions, Motor Assessment Scales of upper arm (MAS-UA) and hand (MAS-H) were measured as indicated. Both MAS-UA and MAS-H did not change after 4-week of TSE training, but significantly increased after 4-week consecutive ES+TSE in group A (Table 7). On the other hand, there was no observable change in group B. These results may

indicate that ES+TSE is an effective intervention when motor is initially prepared by

TSE for 4 weeks.

Table 7 Comparison of Motor Assessment Scale at week 1st, 5th and 9th in each group

Motor Assessment Scale	Week 1st median (min-max)	Week 5th median (min-max)	Week 9th median (min-max)	P-values		
				Week 1st vs 5th	Week 5th vs 9th	Week 1st vs 9th
Group A: TSE/ ES+TSE						
MAS-UA	2 (1-6)[a]	2.5 (1-6)[a]	3.5 (1-6)[b]	1	0.18	0.034*
MAS-H	0 (0-5)[a]	0 (0-5)[a]	0 (0-6)[b]	0.083	0.18	0.034*
Group B: ES+TSE/ TSE						
MAS-UA	3 (1-6)[a]	3 (1-6)[a]	3 (1-6)[a]	1	0.317	0.102
MAS-H	0 (0-5)[a]	0 (0-6)[a]	0 (0-6)[a]	-	-	-

*P<0.05; between group comparison using the Wilcoxon Signed Ranks test.

(-) Friedman test *P*>0.05

4.3 Active range of motion (AROM)

To examine the involvement of joint of TSE and ES+TSE, AROM of the shoulder, the elbow, and the wrist were determined (Table 8). Results showed that after 8-week training most of joint AROM increased in both groups except only for elbow extension in both groups and shoulder abduction in group B. Even though shoulder abduction also showed tendency to increase after 4-week of ES+TSE, it was significant only in group A. Notably, wrist motion was increased in every group after 4-week training with ES+TSE.

Table 8 Comparison of AROM at week 1st, 5th and 9th in each group

AROM (degree)	Week 1st (mean±SE)	Week 5th (mean±SE)	Week 9th (mean±SE)	*P*-values		
				Week 1st vs 5th	Week 5th vs 9th	Week 1st vs 9th
Group A: TSE/ ES+TSE AROM						
Shoulder abduction	102.3±16.3[a]	114.9±16.9[b]	127.4±14.5[c]	0.005**	0.013*	0.005**
Elbow flexion	113.9±9.1[a]	121.3±6.8[a,b]	124.6±7.3[b]	0.093	0.307	0.008**
Elbow extension	155.4±12.1[a]	162.6±7.5[a]	166.7±8.1[a]	-	-	-
Wrist flexion	8.3±4.3[a]	13.2±5.3[b]	26.5±6.8[c]	0.028*	0.021*	0.008**
Wrist extension	18.3±6.9[a]	24.5±7.5[a]	41.1±8.2[b]	0.128	0.018*	0.012*
Group B: ES+TSE/ TSE AROM						
Shoulder abduction	113.1±17.2[a]	123.7±17.7[a]	113.9±19.6[a]	-	-	-
Elbow flexion	120.5±13.9[a]	122.6±14. [a, b]	122.5±15.9[b]	0.075	0.207	0.036*
Elbow extension	145.8±18.2[a]	148.4±18.5[a]	144.7±20.4[a]	-	-	-
Wrist flexion	19.0±7.3[a]	28.2±9.4 [b]	25.4±10.3[b]	0.028*	0.068	0.043*
Wrist extension	28.4±9.6[a]	34.0±11.6[b]	36.6±11.0[a]	0.043*	0.686	0.042*

*P<0.05; ** P<0.01; between group comparison using the Wilcoxon Signed Ranks test. (-) Friedman test *P*>0.05.

4.4 Passive range of motion (PROM)

Table 9 showed that shoulder and hand PROM increased in most of the groups, except for wrist extension in group B. Overall, shoulder PROM improved just after 4-week of interventions (either TSE or ES+TSE), suggesting joint mobility-related increase in functional abilities. Thus, improvements in arm and hand functional abilities were associated with increased passive range of motion (PROM).

Table 9 Comparison of PROM at week 1st, 5th and 9th in each group

PROM (degree)	Week 1st mean±SE	Week 5th mean±SE	Week 9th mean±SE	*P*-values		
				Week 1st vs 5th	Week 5th vs 9th	Week 1st vs 9th
Group A: **TSE/ ES+TSE** PROM						
Shoulder flexion	157.0 ± 4.5^a	162.2 ± 5.4^b	168.6 ± 4.3^c	0.035*	0.028*	0.009*
Shoulder abduction	166.5 ± 4.6^a	$170.3\pm4.7^{a,b}$	173.8 ± 4.4^b	0.109	0.108	0.008**
Elbow flexion	144.1 ± 1.5^a	145.5 ± 1.4^a	146.4 ± 1.7^a	-	-	-
Elbow extension	178.3 ± 1.8^a	179.7 ± 0.3^a	180.0 ± 0.0^a	-	-	-
Wrist flexion	86.2 ± 1.7^a	87.9 ± 1.5^b	90.4 ± 0.8^c	0.034*	0.027*	0.005**
Wrist extension	85.5 ± 1.1^a	86.9 ± 1.2^a	89.8 ± 0.6^b	0.221	0.024*	0.008**
Group B: **ES+TSE/ TSE** PROM						
Shoulder flexion	158.3 ± 5.6^a	166.2 ± 3.9^b	171.5 ± 4.3^c	0.043*	0.018*	0.028*
Shoulder abduction	170.6 ± 3.1^a	176.6 ± 2.7^b	176.7 ± 3.3^b	0.018*	0.285	0.046*
Elbow flexion	146.7 ± 1.8^a	149.0 ± 1.1^a	149.8 ± 1.7^a	-	-	-
Elbow extension	180.0 ± 0.0^a	180.0 ± 0.0^a	180.0 ± 0.0^a	-	-	-
Wrist flexion	83.7 ± 2.2^a	85.9 ± 1.8^a	89.4 ± 0.4^a	0.116	0.116	0.116
Wrist extension	82.4 ± 4.8^a	83.9 ± 4.6^b	85.4 ± 4.5^b	0.031*	0.069	0.038*

*P<0.05; ** P<0.01; between group comparison using the Wilcoxon Signed Ranks test. (-) Friedman test *P*>0.05.

4.5 Data of the goal functional task

To investigate effects of TSE and ES+TSE training on performance of motor functions, movement time or AROM of the goal functional task were recorded. Data at the week 1st were set as baseline, the percentage of changes compared to the week 1st was determined. The average and the standard deviation of the percentage of changes are presented in Table 10. There was improvement in movement time in both of TSE and ES+TSE training. These results indicated that both of TSE and ES+TSE could increase voluntary motor functional ability.

Table 10 Data of the goal functional task performed in individual

Goal functional task (mean±SD)			
Group A: TSE/ ES+TSE		**Group B: ES+TSE/TSE**	
Participant 1	Reaching task	Participant 11	Stacking 3 checkers
Participant 2	Reaching task	Participant 12	Reaching task
Participant 3	Flex and extend elbow to starting position	Participant 13	Reaching task
Participant 4	Reaching task	Participant 14	Reaching task
Participant 5	Flipping 3 cards	Participant 15	Elbow flexion to extension (degree)
Participant 6	Reaching task	Participant 16	Flipping 3 cards
Participant 7	Reaching task	Participant 17	Reaching task
Participant 8	Reaching task	Participant 18	Elbow flexion to extension (degree)
Participant 9	Reaching task	Participant 19	Flipping 3 cards
Participant 10	Reaching task	Participant 20	Stacking 3 checkers
Week 1st (%)	100±0.0	Week 1st (%)	100.0±0.0
Week 5th (%)	70.8±42.0	Week 5th (%)	93.8±56.5
Week 9th (%)	54.6±30.2	Week 9th (%)	82.3±30.7

4.6 Spasticity

Spasticity is one of factors burdensome functional movement. Modified Ashworth scale was applied to verify effects of the interventions on muscle tone. As shown in Table 11, there was only decrease in tonicity of wrist flexors at week 5th and 9th after ES+TSE in group A.

Table 11 Comparison modified Ashworth scale at week 1st, 5th and 9th in each group

modified Ashworth scale	Week 1st median (min-max)	Week 5th median (min-max)	Week 9th median (min-max)	*P*-values		
				Week 1st vs 5th	Week 5th vs 9th	Week 1st vs 9th
Group A: TSE/ ES+TSE						
Biceps brachii	1 (0-2)[a]	1 (0-2)[a]	1 (0-2)[a]	-	-	-
Triceps brachii	0 (0-2)[a]	1 (0-2)[a]	0.5 (0-1)[a]	-	-	-
Wrist flexors	2 (0-2)[a]	2 (2-2)[b]	0.5 (0-2)[c]	0.063	0.006**	0.023*
Wrist extensors	0 (0-0)[a]	0 (0-0)[a]	0 (0-0)[a]	-	-	-
Group B: ES+TSE/ TSE						
Biceps brachii	1 (0-2)[a]	1 (0-2)[a]	1 (0-2)[a]	-	-	-
Triceps brachii	1 (0-2)[a]	0.5 (0-2)[a]	0 (0-1)[a]	-	-	-
Wrist flexors	1 (0-2)[a]	1 (0-2)[a]	1 (0-2)[a]	-	-	-
Wrist extensors	0 (0-1)[a]	0 (0-1)[a]	0 (0-1)[a]	-	-	-

*P<0.05; ** P<0.01; between group comparison using the Wilcoxon Signed Ranks test. (-) Friedman test *P*>0.05

4.7 Light touch and pinprick sensation

Only one participant in group A and group B had improvements both of light touch and pinprick sensation from impaired to intact at week 9th (Table 12).

Table 12 Data of sensation at week 1st, 5th and 9th in each group

Participants	light touch			pinprick		
	Week 1st	Week 5th	Week 9th	Week 1st	Week 5th	Week 9th
Group A: TSE/ ES+TSE						
Participant 1	intact	intact	intact	intact	intact	intact
Participant 2	impaired	impaired	impaired	impaired	impaired	impaired
Participant 3	impaired	impaired	impaired	impaired	impaired	impaired
Participant 4	intact	intact	intact	intact	intact	intact
Participant 5	intact	intact	intact	intact	intact	intact
Participant 6	impaired	impaired	Intact*	impaired	impaired	Intact*
Participant 7	intact	intact	intact	intact	intact	intact
Participant 8	impaired	impaired	impaired	impaired	impaired	impaired
Participant 9	impaired	impaired	impaired	impaired	impaired	impaired
Participant 10	impaired	impaired	impaired	impaired	impaired	impaired
Group B: ES+TSE/ TSE						
Participant 11	intact	intact	intact	intact	intact	intact
Participant 12	intact	intact	intact	intact	intact	intact
Participant 13	impaired	impaired	Intact*	impaired	impaired	intact*
Participant 14	intact	intact	intact	intact	intact	intact
Participant 15	intact	intact	intact	intact	intact	intact
Participant 16	intact	intact	intact	intact	intact	intact
Participant 17	intact	intact	intact	intact	intact	intact
Participant 18	intact	intact	intact	intact	intact	intact
Participant 19	intact	intact	intact	intact	intact	intact
Participant 20	intact	intact	none	intact	intact	nt

nt=not test

4.8 Evaluation of participants' satisfaction toward the treatments

Most of participants expressed positive attitude toward TSE and ES+TSE programs. All of them agreed that the programs were easy to use and helpful to improve their functional abilities (Table 13, 14). Pertaining to the duration of interventions, even though most of them found that it was appropriate, some commented on too-short period of treatments. They preferred both ES+TSE and TSE

alone. Finally, they felt that our team was caring and helpful. In conclusion, users were in preference for the provided treatments both TSE and ES+TSE.

Table 13 The summary of agreement levels for task-specific exercise program.

Items	Levels of acceptance or agreement				
	Extremely agree (5)	Very agree (4)	Moderate agree (3)	Low agree (2)	Disagree (1)
1) It was easier to use a paretic arm after 4-week task-specific exercises	45% (9)	20% (4)	30%(6)	0%(0)	0%(0)
2) Generally spoken, arm exercise program was useful	45% (9)	30% (6)	20% (4)	0% (0)	0% (0)
3) It was difficult to perform the provided exercises	5% (1)	20% (4)	35% (7)	25% (5)	0% (0)
4) Duration of training was appropriate (1 hour/day, 5 days/week)	55% (11)	30% (6)	15% (3)	0% (0)	0% (0)
5) Our follow-up sessions were suitable and ample	50% (10)	35% (7)	10% (2)	0% (0)	0% (0)
6) The research team was supportive when you have needed help	45% (9)	30% (6)	15% (3)	0% (0)	0% (0)
7) The research team was capable	50% (10)	35% (7)	10% (2)	0% (0)	0% (0)
8) You could perceive the difference between task-specific exercise only and that combined with home-based electrical stimulation (respond only if you completed the 8-week program)	20% (2)	40% (4)	10% (1)	10% (1)	10% (1)

Values presented as percentage (number) of participants. Note: there were n=19 in item 1 to 7 and n=9 in item 8.

Table 14 The summary of agreement levels for electrical stimulation combined with

task-specific exercise program

Items	Levels of acceptance				
	Extremely agree (5)	Very agree (4)	Moderate agree (3)	Low agree (2)	Disagree (1)
1) It was easier to use a paretic arm after 4-week electrical stimulation	50% (10)	20% (4)	30% (6)	0% (0)	0% (0)
2) Generally spoken, arm electrical stimulation was useful	55% (11)	20% (4)	25% (5)	0% (0)	0% (0)
3) It was difficult to use an electrical stimulator	0% (0)	5% (1)	20% (4)	50% (10)	25% (5)
4) It was difficult to positioning electrodes	0% (0)	0% (0)	20% (4)	50% (10)	30% (6)
5) Duration of stimulation was appropriate (1 hour/day, 5 days/week)	35% (7)	30% (6)	35% (7)	0% (0)	0% (0)
6) Our follow-up sessions were suitable and ample	45% (9)	45% (9)	10% (2)	0% (0)	0% (0)
7) The research team was supportive when you needed help	45% (9)	45% (9)	10% (2)	0% (0)	0% (0)
8) The research team was capable	50% (10)	45% (9)	5% (1)	0% (0)	0% (0)
9) You could perceive the difference between task-specific exercise only and that combined with home-based electrical stimulation (respond only if you completed the 8-week program)	40% (4)	40% (4)	0% (0)	10% (1)	10% (1)

Values presented as percentage (number) of participants. Note: there were n=20 in

item 1 to 8 and n=10 in item 9.