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Effects of Upper Extremity Rehabilitation Using Smart Glove in Subacute Stroke Patients

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Background/Objective
About half of stroke survivors have upper extremity dysfunction. Although many trials and various interventions aiming to regain arm and hand function have been conducted, restoring upper limb function still remains a challenge. The aim of this study is to investigate the effect of smart glove for upper extremity rehabilitation in subacute stroke patients.

Methods
A single-blinded, randomized, controlled study was conducted on the patients who 1) were 19 years old or older, 2) had a first stroke within three months confirmed by CT or MRI, 3) had upper extremity hemiplegia with Brunnstrom stage 2 to 5, and 4) could tolerate sitting at least one hour of intervention. Exclusion criteria were patients with 1) severe hemineglect or hemianopia, 2) upper extremity contracture, 3) Fugl-Meyer Assessment-Wrist & Hand score ≥ 21, 4) upper extremity spasticity in the wrist and fingers with modified Ashworth scale ≥ 3, and 5) moderate to severe cognitive dysfunction (MMSE < 18). Eligible participants were randomly allocated to the smart glove training (SGT) group or the conventional occupational therapy (COT) group. Participants in the SGT group received 30 minutes of standard occupational therapy followed by 30 minutes of upper extremity training with smart glove, the RAPAEL Smart GloveTM (Neofect, Yong-in, Korea), while the COT group received standard occupational therapy for 30 minutes followed by upper extremity rehabilitation homework, self-training at bedside, for 30 minutes. All participants received each intervention five days a week for two consecutive weeks. The primary outcome was the Fugl-Meyer Assessment-upper extremity (FMA-UE). Secondary outcomes included the Jebsen Hand Function Test (JHFT), Box and Block Test (BBT), grip power, Modified Barthel Index-Upper Extremity (MBI-UE), and Caregiver Burden Scale (CBS). Participants were evaluated before (T1), immediately after (T2) and six weeks after the intervention (T3). This study protocol was registered at ClinicalTrials.gov (NCT02592759).

Results
A total of 23 patients were enrolled in this study. Table 1 shows the baseline characteristics of the participants. Table 2 shows the changes in the outcomes between before and immediately after intervention. There was no statistical difference of short-term efficacy. Table 3 shows the changes in the outcomes between before and six weeks

after intervention. After six weeks, the FMA-UE score was significantly greater in the SGT group compared with the COT group (p=0.023). There were no significant changes in other outcome measures.

Conclusion

Upper extremity rehabilitation using smart glove may reduce upper extremity impairment in subacute stroke patients.

Table 1. Clinical characteristics of the participants (n=23)

Characteristics	SGT group (n=12)	COT group (n=11)
Age (in years)	50.92 ± 16.68	64.64 ± 13.83
Sex		
Male	7 (58.3%)	5 (45.5%)
Female	5 (41.7%)	6 (54.5%)
Hemiplegic side		
Right	5 (41.7%)	3 (27.3%)
Left	7 (58.3%)	8 (72.7%)
Stroke type		
Hemorrhagic	6 (50.0%)	5 (45.5%)
Infarct	6 (50.0%)	6 (54.5%)
Time to onset (in days)	30.75 ± 20.01	17.91 ± 11.05
MMSE	24.83 ± 3.33	26.27 ± 3.17
FMA-UE	33.83 ± 13.99	35.55 ± 15.06
JHFT	7.00 ± 11.70	9.09 ± 17.48
BBT	10.75 ± 12.93	9.91 ± 15.20
Grip power	12.33 ± 10.49	14.71 ± 18.04
MBI-UE	16.83 ± 6.24	11.55 ± 5.66
CBS	10.50 ± 3.87	12.82 ± 4.33

Variables are presented as a number (%) or a mean ± standard deviation.

SGT, Smart Glove Training; COT, Conventional Occupational Therapy; MMSE, Mini-Mental State Examination; FMA-UE, Fugl-Meyer Assessment-upper extremity; JHFT, Jebsen Hand Function Test; BBT, Box and Block Test; MBI-UE, Modified Barthel Index-Upper Extremity; CBS, Caregiver Burden Scale.

Table 2. The changes in the outcomes between before and immediately after intervention

	SGT (T2-T1)	COT (T2-T1)	*p*-value
FMA-UE	14.00 ± 8.91	9.55 ± 11.60	0.316
JHFT	18.92 ± 21.78	17.82 ± 20.54	0.928
BBT	8.33 ± 9.41	13.00 ± 9.86	0.235
Grip Power	7.42 ± 6.76	9.09 ± 14.51	0.695
MBI-UE	3.92 ± 3.75	8.45 ± 5.73	0.051
CBS	-3.25 ± 2.18	-2.91 ± 2.39	0.695

Variables are presented as mean ± standard deviation.

SGT, Smart Glove Training; COT, Conventional Occupational Therapy; T1, before intervention; T2, immediately after intervention; T3, six weeks after intervention; FMA-UE, Fugl-Meyer Assessment-upper extremity; JHFT, Jebsen Hand Function Test; BBT, Box and Block Test; MBI-UE, Modified Barthel Index-Upper Extremity; CBS, Caregiver Burden Scale.

Table 3. The changes in the outcomes between before and six weeks after intervention

	SGT (T3-T1)	COT (T3-T1)	*p*-value
FMA	21.58 ± 9.55	11.36 ± 8.02	0.023*
JHFT	33.08 ± 21.18	20.55 ± 23.59	0.288
BBT	20.58 ± 15.18	13.91 ± 9.19	0.260
Grip Power	12.33 ± 11.91	9.32 ± 8.49	0.608
MBI-UE	8.33 ± 6.15	10.09 ± 7.08	0.786
CBS	-4.33 ± 2.31	-3.45 ± 2.30	0.566

Variables are presented as mean ± standard deviation.

SGT, Smart Glove Training; COT, Conventional Occupational Therapy; T1, before intervention; T2, immediately after intervention; T3, six weeks after intervention; FMA-UE, Fugl-Meyer Assessment-upper extremity; JHFT, Jebsen Hand Function Test; BBT, Box and Block Test; MBI-UE, Modified Barthel Index-Upper Extremity; CBS, Caregiver Burden Scale.

*$p<0.05$