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The effect of a driving simulator based rehabilitation on cognitive functions in subacute survivors

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Objective
Driving is complex activity that requires intact perceptional, cognitive, behavioral and motor functions. To drive safely, drivers should recognize and respond to lots of visuoperceptive informations. Because stroke can cause not only deteriorations in motor control but also those in cognitive function, communication and emotional areas, patients who were able to drive before stroke also need to be evaluated and trained their driving ability to drive safely. Since rehabilitation using driving simulator requires various cognitive functions, it is also expected that cognitive function will be improved after simulator training. Devos et al. reported that using a driving simulator in patients with Parkinson's disease helped to improve their on-road driving and driving related cognitive skills. However, to our knowledge, there is no research to find out how the driving rehabilitation affects the cognitive function of stroke patient. The Purpose of study is to investigate the effects of driving simulator training on cognitive functions in subacute stroke survivors.

Methods
Inclusion criteria were: (1) history of first stroke within 6 months, documented by CT or MRI; (2) Korean version of Mini-mental status exam(K-MMSE) ≥ 24; and 3) A person who can maintain balance in sitting position. Exclusion criteria were: (1) severe neurologic deficits by stroke that make simulator training difficult; (2) Other neurologic deficits that can affect cognitive and motor functions except stroke. Participants were randomly assigned in two groups. Driving simulator group (D) conducted both driving simulator training and computer based cognitive rehabilitation (30 minutes/day and five times/week for 3 weeks, respectively). Control group (cognitive rehabilitation group; C) conducted only computer based cognitive rehabilitation (one hour/day and five times/week for 3 weeks). Driving Health Inventory (divided visual search; DVS , Useful Field of View; UFOV,), computerized neurocognitive test (Trail Making Test A, Digit Span Test, Card Sorting Test, Word Color Test), modified Barthel Index (MBI) and Beck Depression Inventory (BDI) were evaluated pre and post treatment.

Results
Eight patients were recruited for this study. The demographics and baseline characteristics in the two groups did not differ significantly (Table 1). All Result

parameters showed no significant difference between pre and post interventions in both groups. However, in both groups, DVS, UFOV and BDI tended to decrease and the other parameters to increase after training. There was no significant group difference in pre/post changes in all parameters (Table 2).

Conclusion

In stroke patients, driving simulator based rehabilitation may have possibility to improve cognitive function as much as computer based cognitive rehabilitation. To clarify these Results, larger sample sizes will be needed.

Table 1. Demographics and clinical characteristics of study subjects

Variable	Total	Driving	Comcog	p-value
	(N=8)	(N=4)	(N=4)	
Age (year)	44.75 ± 5.1	41.75± 7.8	47.75± 7.5	0.686
Sex				0.317
Male	7(87.5%)	4(100.0%)	3(75.0%)	
Female	1(12.5%)	0(0.0%)	1(25.0%)	
Affected side				0.317
Right	1(12.5%)	0(0.0%)	1(25.0%)	
Left	7(87.5%)	4(100.0%)	3(75.0%)	
Etiology				0.495
Infarction	3(37.5%)	1(25.0%)	2(50.0%)	
Hemorrhage	5(62.5%)	3(75.0%)	2(50.0%)	
K-MMSE	26.75± 0.8	27.75 ± 1.2	25.75 ± 1.1	0.268

K-MMSE, Korean version of Mini-mental status exam
Data were reported as mean±standard deviation for continuous variables and n (%) for categorical variables.

Table 2. Comparison between 2 groups; pre and post treatment

Variable	Group	Pre	Post	p-value*	Δ (Post - Pre)	p-value†
DVS	D	114.2 ± 52.3	90.0 ± 38.5	0.068	-24.2 ± 14.1	0.083
	C	187.5 ± 86.5	127.5 ± 61.8	0.068	-60.0 ± 29.4	
UFOV	D	225.7 ± 163.0	160.0 ± 101.6	0.066	-65.7 ± 61.4	0.486
	C	311.2 ± 165.3	214.2 ± 122.6	0.066	-97.0 ± 59.7	
TMT(A)	D	45.7 ± 9.0	55.0 ± 5.7	0.066	9.2 ± 4.9	0.686
	C	33.5 ± 7.5	43.7 ± 10.3	0.066	10.2 ± 3.3	
DST(F)	D	36.0 ± 7.5	44.2 ± 7.4	0.068	8.2 ± 3.3	0.486
	C	50.3 ± 33.2	59.3 ± 28.3	0.109	9.0 ± 11.1	
DST(B)	D	47.0 ± 3.5	54.5 ± 4.2	0.068	7.5 ± 2.0	0.200
	C	52.2 ± 27.6	64.2 ± 27.1	0.068	12.0 ± 4.6	
CST	D	46.0 ± 11.1	52.2 ± 11.8	0.066	6.2 ± 0.9	0.200
	C	31.7 ± 3.5	41.7 ± 6.2	0.068	10.0 ± 3.5	
WCT	D	38.5 ± 10.0	44.0 ± 8.9	0.066	5.5 ± 1.9	0.114
	C	40.2 ± 24.5	52.7 ± 22.6	0.068	12.5 ± 7.0	
MBI	D	62.0 ± 29.1	70.25 ± 34.2	0.109	8.2 ± 7.4	0.057
	C	31.7 ± 3.5	72.5 ± 19.7	0.068	25.0 ± 9.1	
BDI	D	21.0 ± 4.3	11.0 ± 2.5	0.068	-10.0 ± 2.5	0.343
	C	17.7 ± 7.7	10.2 ± 5.5	0.066	-7.5 ± 3.0	

DVS, divided visual search(s); UFOV, Useful Field of View(ms); TMT(A), Trail Making Test A (t-score); DST(F), Digit Span Test forward(t-score); DST(B), Digit Span Test backward(t-score); CST, Card Sort Test(t-score); WCT, Word Color Test(t-score); MBI, modified Barthel Index; BDI, Beck Depression Inventory; D, driving simulator group; C, computer based rehabilitation group.
Data were reported as mean±standard deviation.
*** P-values were calculated by Wilcoxon's signed-rank test.**
† P-values were calculated by Mann-Whitney test.