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Original Article

Cognitive basis about risk level classifications for the self-assessment of older drivers

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Abstract. [Purpose] This study analyzed the cognitive functions according to risk level for the Driver 65 Plus measure, and examined the cognitive basis of self-assessment for screening the driving risk of elderly drivers. [Subjects and Methods] A total of 46 older drivers with a driver's license participated in this study. All participants were evaluated with Driver 65 Plus. They were classified into three groups of "safe," "caution" and "stop," and examined for cognitive functions with Trail Making Test and Montreal Cognitive Assessment-K. The cognitive test results of the three groups were compared. [Results] Trail Making Test-A, Trail Making Test-B, and Montreal Cognitive Assessment-K showed a significant difference between the three groups. The safe group showed significantly higher ability than the caution and stop groups in the three cognitive tests. In addition, cognitive functions of naming, attention, language, and delayed recall were significantly different between the three groups. [Conclusion] Self-assessment of older drivers is a useful tool for screening the cognitive aspects of driving risk. The cognitive functions, such as attention and recall, are the critical factors for screening the driving risk of elderly drivers.
Key words: Cognitive functions, Elderly driving, Self-assessment

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INTRODUCTION

Driving ability of older drivers is reduced due to the overall dysfunction involved in the natural aging process[1]. Almost half of all drivers are older, and their accident rate has continued to increase[2, 3]. Therefore, recently, elderly driving experts have committed to the screening of at-risk older drivers to prevent accidents[4].

The accident risk of drivers has been reported to be highly relevant to motor ability, cognitive function, self-regulation ability, and medical condition[5, 6]. In particular, cognitive functions have been reported as a key screening element in the elderly driver due to characteristics of the aging process[7]. Therefore, cognitive assessment is used as a driving screening tool for older drivers[4]. The commonly used cognitive tests include the Trail Making Test (TMT), Montreal Cognitive Assessment (MOCA), Useful Field of View (UFOV), Mini Mental State Examination (MMSE), and Clock Drawing Test (CDT)[8–10].

Older drivers have a self-regulation that can prevent accidents by enhancing the sensitivity to the changes due to aging[11]. This ability can be measured through behavior that occurs during the operation of the self-assessment, and it can be used to monitor the broader population[12]. The major self-assessments include Driver 65 Plus, the Safe Driving Behavior Measure, SAFER Driving, and the Driving Decisions Workbook, among others[13]. In particular, Driver 65 Plus consists of 15 questions, and it is relatively simple to use; as such, the facilitation of the monitoring of low concentration elderly drivers is an advantage[14].

Despite this advantage, the reliability of the evaluation report by the elderly themselves is no less a problem[14]. Therefore, further evidence that the accuracy of older drivers' self-assessment in driving-related function is needed to use it for rehabili-

Table 1. General and driving related characteristics of the participants (n=46)

Characteristics	Safe group (n=12)	Caution group (n=26)	Stop group (n=8)	F
Gender (male/female)	11/1	20/6	5/3	1.362
Age (years)	75.8 ± 5.9	74.6 ± 4.6	74.0 ± 5.2	0.234
Education (pre/middle/high/above)	3/1/2/6	4/5/11/6	2/3/2/1	1.405
Past driving experience (<10/10–20 />20 years)	1/3/8	3/5/18	3/1/4	0.523
Driving time per week (<3/3–4/4–5 />5 hours)	5/2/1/4	11/6/6/3	7/1/0/0	2.668
Accidents resent three months (yes/no)	0/12	2/24	0/8	0.819

tation of elderly drivers[15–17]. The research that confirms the ability to the discrimination of the driving-related functions with self-assessment will provide the basis for the screening of driving risk in rehabilitation of older drivers. In particular, verification of cognitive function, a key element in elderly driving, will be an important basis for elderly driving rehabilitation.

Driver 65 Plus separates the elderly drivers into "Safe", "Caution", "Stop" groups, depending on their score. Therefore, the analysis on the differences in cognitive function according to the classification may identify whether there are cognitive effects of screening the risk of self-assessment.

The purpose of this study was to confirm the basis for screening the driving risk of self-assessment through analysis of cognitive functions, in accordance with the classification of Driver 65 Plus.

SUBJECTS AND METHODS

Forty-seven older drivers with a driver's license were recruited from August to September 2016. The study participants were enrolled from a senior citizens' center of Korea. All study protocols were presented to all subjects and written informed consent was obtained from all participants in accordance with the ethical standards of the Declaration of Helsinki, 1995. Participants with no senile and neurological disease were included. One participant with an incomplete assessment was excluded. Forty-six older drivers participated in this study. Table 1 lists the personal and driving-related characteristics of the participants. There was no significant difference among the three groups.

This study was carried out by dividing the process into four steps. In the first step, Driver 65 Plus was used to evaluate the driving risk of the participants. In the second step, the subjects were classified into three groups according to their score of Driver 65 Plus. In the next step, the safe group (n=12), the caution group (n=26) and the stop group (n=8) underwent a cognitive function assessment. In the final step, the cognitive test results of the three groups were compared.

Driver 65 Plus is a self-assessment for screening the risk of the driver, and it was developed by the AAA (Australian Automobile Association) Foundation for Traffic Safety. It consists of 15 questions that ask about the behaviors or conditions associated with driving. The combined scores of each question are defined as "0–15, safe driving," "16–34, caution driving," and "≥35, stop driving"[18]. MOCA-K measures visuospatial executive function, naming, attention, language, abstraction, delayed recall. It was reported to be associated with driving[9]. The TMT is divided into the A or B type. TMT-A measures the response time, attention, sequencing, and visual scanning; and additionally, TMT-B measures the shift-attention, executive function, and decision-making. They are used to predict driving risk due to the high association with elderly drivers[19].

SPSS 18.0 was used for statistical analysis. An one-way ANOVA was used to assess the differences in the cognitive functions between the three groups. A p value<0.05 was considered statistically significant.

RESULTS

As listed in Table 2, TMT-A, TMT-B, and MOCA-K showed significant differences between the three groups. The safe group showed higher ability in the three cognitive tests than in the caution and stop groups. Additionally, the caution group showed higher ability in the TMT-B and MOCA-K than the stop group. The four items showed a significant difference between the three groups. The safe group showed higher ability in the items of naming, attention, and language than the stop group. On the other hand, the safe group showed higher ability in the item of delayed recall than the caution and stop groups.

DISCUSSION

This study classified elderly drivers into "safe," "caution," and "stop" groups through Driver 65 Plus. TMT and MOCA-K were significantly different between the three groups. Thus, it confirmed the cognitive basis for the prediction of the risk of elderly drivers with Driver 65 Plus.

Through Scheffe posteriori test results, TMT-B significant differences were found in all comparisons between the three groups. In contrast, TMT-A was significant different only between safe and stop groups. It is interpreted that this was due

Table 2. Comparison of the cognitive functions between three groups

		Safe group (n=12)	Caution group (n=26)	Stop group (n=8)	F
TMT	TMT-A (second)	$46.88 \pm 13.45^{a*}$	62.65 ± 30.39	$83.25 \pm 30.00^{a*}$	4.362*
	TMT-B (second)	$103.18 \pm 54.15^{a*,c***}$	$165.43 \pm 61.23^{a*,b*}$	$232.32 \pm 38.53^{b*,c***}$	12.820***
MOCA-K	Total (score)	$27.12 \pm 1.70^{a*,c***}$	$23.42 \pm 4.10^{a*,b*}$	$19.50 \pm 4.81^{b*,c***}$	10.060***
	Visuospatial executive	4.00 ± 1.13	3.92 ± 1.29	2.75 ± 1.28	3.040
	Naming	2.92 ± 0.29	2.81 ± 0.57	2.25 ± 0.89	3.591*
	Attention	$5.83 \pm 0.39^{a*}$	4.81 ± 1.36	4.00 ± 1.77^{a}	5.274**
	Language	$3.00 \pm 0.00^{a**}$	2.73 ± 0.53	$2.25 \pm 0.71^{a**}$	5.490**
	Abstraction	1.67 ± 0.65	1.23 ± 0.77	1.00 ± 0.76	2.269
	Delayed recall	$3.83 \pm 1.40^{a*,b*}$	1.92 ± 1.83^{a}	$1.63 \pm 1.92^{b*}$	5.781**
	Orientation	5.92 ± 0.29	5.77 ± 0.99	5.63 ± 0.52	0.329

MOCA-K: Korean version of the montreal cognitive assessment; TMT-A: trail making test-A; TMT-B: trail making test-B
abc Scheffe, *$p<0.05$, **$p<0.01$, ***$p<0.001$

to TMT-B having more measures on decision-making, executive function and shift attention, compared to the TMT-A[20]. Driving is a highly complex task that requires attention, memory, response time, decision-making, and executive function, among other factors[21]. Therefore, this can be seen in the results of TMT-B, which measured high-level cognitive function more sensitively. This result is consistent with the pre-study that indicated that TMT-B was more effective in predicting the risk of senior drivers[19].

MOCA-K (used to measure the overall cognitive functions[9]) was significantly different in all of comparisons between three groups. In addition, it was confirmed that a significant difference between the sub-areas of naming, attention, language, delayed recall was present. Older drivers are required to have cognitive functions such as shift-attention, selective-attention, processing speed, long-term memory, and decision-making[22]. Because of this characteristic, it is assumed that there is a difference in the attention and delayed recall of the study. The difference of the language was determined to be caused by the evaluation method of Driver 65 Plus. Elderly drivers with a high vocabulary can respond better to these evaluations that require reading and understanding.

In the other measure, the cognitive functions of orientation and abstraction were also related with older drivers. But, a significant difference between the groups was not reported. Nevertheless, the mean of the safe group was higher than the caution and stop groups. In general, the mean difference analysis is sensitive to the increase of the number of subjects in the sample[23]. Because of the limited sample, it is estimated that the cognitive functions did not show a statistically significant difference in this study.

Therefore, future research studies that include a sufficient sample size will be needed to provide strong evidence. This study confirmed the cognitive basis of self-assessment for elderly drivers. This finding can be used as the evidence for screening dangerous older drivers through self-assessment in elderly drivers' rehabilitation. Besides this, a multifaceted study related to older drivers will be required.

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