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Brief communication (Original)

Executive dysfunction among mild traumatic brain injured patients in Northeastern Thailand

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Background: Mild traumatic brain injury (TBI) is a common neurological disorder. Cognitive impairment is a result of TBI, and executive function is impaired in various degree of injury. Few data are available for assessment of executive dysfunction in Thai patients.
***Objective*:** Examine prevalence and factors influencing executive dysfunction among mild TBI patients in Thailand.
Materials and methods: A cross-sectional descriptive study was conducted to determine the prevalence of 60 mild TBI patients. The patients were selected from those who were admitted at Khon Kaen Hospital between September and December 2009. Patients with previously major psychiatric or neurological disorders and currently confused or depressed were excluded. The executive function was measured by the Wisconsin Card Sorting Test (WCST), and the data was analyzed statistically.
Results: Prevalence of executive dysfunction among the patients was 21.7%. Primary education level and low monthly salary were two factors to be associated with dysfunction. Alcohol use was associated with WCST score, but not with the dysfunction. However, severity of injury had no significant association with both the dysfunction and WCST score.
Conclusion: Executive dysfunction in mild TBI patients was high (21.7% prevalent in Northeastern Thailand). Primary education level and low monthly salary were associated with dysfunction.

Keywords: Cognitive function, executive dysfunction, mild traumatic brain injury, Northeastern Thailand

Traumatic brain injury (TBI) is a common neurological disorder. The mild severity is the most common, and 50-80% of all TBI [1]. Cognitive impairment is a result of TBI. Attention, memory, language, and executive function are differently impaired in various degree of injury. The executive dysfunction often associates with frontal lobe distress [2, 3]. It is a crucial determinant of functional outcome after TBI, and frequently observed in mild TBI. It is also related to various functional outcomes, such as independency and social integration [4, 5].

Wisconsin Card Sorting Test (WCST) is one of the gold standards for executive function measurement. By using the WCST, Tweeten et al. [6] found approximately 15% dysfunction among 11 mild TBI patients [14]. Miller et al. [7] demonstrated 17.7% dysfunction in 182 of five-year-follow up TBI patients. Gansler et al. [8] found significant impairment in 20 acute TBI patients. However, few data are available for assessment of the executive dysfunction in Thai patients.

In this study, we investigated prevalence of the executive dysfunction among Thai mild TBI patients. We analyzed factors associated with the dysfunction among mild TBI patients in Northeastern Thailand.

Material and methods

A cross-sectional descriptive study was performed with convenient sampling. This study was approved by the Ethics Committee of King Chulalongkorn Memorial Hospital and Khon Kaen Hospital.

Sixty subjects (48 male and 12 female, age: 18-55 years old, mean: 29.5) were recruited from

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the patients admitted at Trauma Unit, Department of Surgery of Khon Kaen Hospital between September and December 2009. Thirty normal (control) subjects (23 male and nine female, age: 18-50 years old, mean: 27.4) were recruited from friends and relatives of the patients. They were matched by age and education without a history of TBI at any severity. Every subjects signed the inform consent.

The inclusion criteria were being mild TBI by American Congress of Rehabilitation Medicine (ACRM)'s criteria [9], being aged between 18-55 years, and can read the Thai language. The exclusion criteria were having past or current diagnosis of major psychiatric or neurological disorders, being currently depressed per the screening by Center for Epidemiologic Studies Depression (CES-D) scale ≥22, being currently confused per the screening by Galveston Orientation and Amnesia Test (GOAT) >75 [10], or having physical challenges that may be problematic for performing the tests such as blindness and deafness.

Patients, who were diagnosed as mild head injury, were appointed to attend the study within two weeks. Subjects were interviewed for demographic and clinical data, and screened for depression and confusion. The data were also compared with the admission records. WCST was administered by an experienced neuropsychologist.

Statistical analysis

All data were analyzed using SPSS for windows version 16.0 for descriptive and inferential statistics. Perseverative errors subscore was used as a dysfunction indicator, which derived from mean plus two standard deviations (SDs) of control group's score. Then, the subject group was identified as "normal" or "impaired". Associated factors were tested using Chi-square, t-test, one-way ANOVA, logistic regression analysis, and multiple linear regression analysis.

Results

Subjects and controls were comparable on monthly income, presenting of underlying medical condition, and alcohol usage (**Table 1**).

Table 2 shows the clinical data of 60 mild TBI patients (subject group). We note that most subjects had no previous history of TBI. For this present incidence, most of them were motorcycle accident with head striking mechanism, had a period of loss of consciousness and post traumatic amnesia and most of them had used alcohol just before the incidence.

Out of the perseverative errors, the control group scored 16.34±7.21, while the subject group scored 22.10±11.27. For both group, the mean was different with statistical significance at $p < 0.005$. This reflected that mild TBI patients were significantly affected on executive function.

The present study found 21.7% prevalence of the executive dysfunction in subject group, by using mean plus two SDs from controls' perseverative errors (mean+2SD =16.34 +2x7.21 = 30.76) as an dysfunction cut-off score. Therefore, one in every five mild TBI patients might have this silent dysfunction.

Table 1. Demographic data of subject (48 male and 12 female, age: 18-55 years old, mean: 29.5) and control group (23 male and 9 female, age: 18-50 years old, mean: 27.4).

Factors	Subject (n=60)		Control (n=32)	
	Number	%	Number	%
Education				
Primary	18	30.0	5	15.6
Secondary	31	51.7	17	53.1
Graduated	11	18.3	10	31.3
Monthly income (Thai Baht)				
None	9	15.0	14	43.75
1-5,000	21	35.0	1	3.13
5001-9,999	21	35.0	5	15.63
≥10000	9	15.0	12	37.50
Mean (Thai Baht)	6408.3		9687.5	
Minimum-maximum (Thai Baht)	0-30,000		0-40,000	
Alcohol use	50	83.3	15	46.9
Patients with previous medical condition(s)	5	8.3	4	12.5

Table 2. Clinical data of subject group (n=60).

Factors	Number	%
Previous TBI	13	21.7
Type of injury		
Motorcycle	43	71.7
Fall	6	10.0
Assaulted	6	10.0
Car	5	8.3
Mechanism of injury		
Contact	57	95.0
Acceleration-deceleration	3	5.0
Alcohol use prior to injury	34	56.7
Focal neurological deficit	1	1.7
Loss of consciousness	52	86.7
Mean: 19.74 minutes		
Minimum-maximum: 0-30.0 minutes		
Post-traumatic amnesia	32	53.3
Mean: 2.93 hours		
Minimum-maximum: 0- 24.0 hour		

Table 3 shows the prevalence of the executive dysfunction and associated factors. We note that only primary school education level and the low (1-5,000 Thai Baht) monthly income were associated with dysfunction with statistical significant at $p < 0.01$.

Two factors, primary school education and 1-5,000 Thai Baht monthly income, were included as significant factors by means of logistic regression analysis (backward method) and at $p < 0.05$ (95%CI=1.14-23.42, 1.34-30.45, p=0.033, 0.020 for primary school education and 1-5,000 Thai Baht monthly income, respectively). In addition, both factors were significantly correlated with WCST perseverative error score in positive direction at $p < 0.001$ and $p < 0.05$, respectively. By contrast, acceleration-deceleration mechanism of injury had more negative correlation with the score than other mechanisms at $p < 0.05$. However, only the education level and low monthly income were included as significant predictors using multiple linear regression analysis. In addition, neither education level nor monthly income was correlated with the perseverative score in control group.

Table 3. Prevalence of the executive dysfunction and associated factors.

Factors	Dysfunction (n=13)		Normal subject (n=47)		Chi-square	P-value
	Number	%	Number	%		
Education level						
Primary	9	69.2	9	19.2	12.16	0.001*
Secondary and above	4	30.8	38	80.9		
Monthly income (Thai Baht)						
(none)	1	7.7	8	17.0	11.51	0.002*
1-5000	10	76.9	11	23.4		
>5000	2	15.4	28	59.6		

*Statistical significance ($p < 0.01$).

Discussion

TBI is defined in patients who have a head injury that disrupt the brain function. In this study, we used ACRM criteria because of its comprehensiveness and acceptance. In general, the injury affects the brain via either focal or diffusive pattern [11, 12]. Diffusive injury is a consequence of acceleration/deceleration to affect white matter and of the secondary injury such as brain edema [2]. Mild TBI causes subtle physical disability. Furthermore, apparent functional difficulty is observed in interpersonal, occupational, and recreational activities [13].

In this study, we used WCST for executive function measurement. It has been verified for lesion and functional neuroimaging, and various clinical conditions [14]. It assesses overall executive function, such as mental flexibility and working memory. Participants have to match 128 cards with four stimulus cards, receiving only accuracy feedback of each match. Rule of matching will change after 10 correct responses without notification [15]. Perseverative error score are calculated by the repeated incorrect match. According to Demakis et al. [16] and Mukhopadhyyay et al. [17], the score may be correlated with dorsolateral prefrontal cortex lesion. In this study, two of SD from control's means score was used as a dysfunction cut-off.

The present results showed that the prevalence of executive dysfunction was 21.7%. The present percents of executive dysfunction was slightly higher than previous studies (15.0% and 17.7%) [6, 7]. This might result from difference in population characteristics. However, this high prevalence should alarm clinicians who take care of traumatic patients to concern on the dysfunction and its impacts.

In the present study, two personal factors (primary school education and 1-5,000 Thai Baht monthly income) reflected premorbid executive function, which were associated with the dysfunction and the WCST score. However, injury severity indicators were not associated in both outcomes.

Primary school education level related to both dysfunction and WCST perseverative errors score. Education level might reflect baseline intelligence, which, in turn, explains premorbid executive function. Although lower education level might be a dysfunction-associated factor, educational impact on the test itself should be considered as pointed out by Arffa [18].

Low monthly income of 1-5,000 Thai Baht related to both dysfunction and WCST perseverative errors score. Similarly to the education level, income might reflect premorbid executive function. Thus, lower income patients had more dysfunction on the test.

Patients with acceleration/deceleration mechanism of injury scored less dysfunction, compared to contact mechanism. This was explained by the fact that the former mechanism generated less injury to the brain, mainly initial force that causes diffusive injury. Contact injury, especially with high velocity impact, generated both direct damage and more diffusive injury to the brain. Therefore, more dysfunction was observed [1]. However, the mechanism of injury was not included as a predictor by means of regression analysis possibly because of few samples on acceleration/deceleration mechanism group.

Injury severity identifiers, which included duration of loss of consciousness, post-traumatic amnesia, and Glasgow coma score, were associated with neither dysfunction nor WCST perseverative errors score. These findings were not conformed in a previous study by Karzmark [19] where injury severity might reflect cognitive outcome of the injury. The study investigated various TBI severities, not like specific severity (only mind dysfunction) in the current study.

In conclusion, the present descriptive study found 21.7% prevalence of executive dysfunction among mild TBI patients in Northeastern Thailand. Low education level and low income were associated with the dysfunction and poorer WCST score, which reflected premorbid baseline executive function. However, injury severity was not associated with the outcomes. Substantial prevalence should illustrate the magnitude of the executive dysfunction in this population.

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