ORIGINAL ARTICLE

A Lower Cognitive Function in Patients with Acute Coronary Syndrome with ST Segment Elevation Compared to Those without ST Segment Elevation

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ABSTRACT

Background: Cognitive impairment may decrease functional status and quality of life. Acute coronary syndrome (ACS) may lead to cognitive impairment.
Aim: To compare the levels of cognitive function between ACS patients with and without ST elevation (STE-ACS vs NSTE-ACS).
Method: This was an observational cross-sectional study using consecutive sampling method. There were 107 subjects that consist of 63 subjects with STE-ACS and 44 subjects with NSTE-ACS at ages ranging from 25-70 years. All subjects were examined for their cognitive function using MoCA-Ina score with blinding for their diagnosis. Statistical test were performed using Mann-Whitney test and non-parametric Spearman correlation test. $p<0.05$ was considered as statistically significant.
Results: There was lower MoCA-Ina score in patients with STE-ACS compared to those with NSTE-ACS (20.8 ± 3.19 vs 23.1 ± 2.47, respectively, $p=0.000$). There were higher levels of CKMB [66 (21 – 292) vs 22 (10 – 132) U/L, $p=0.000$], and troponin [2.6 (0.01 – 22.22) vs 0.04 (0.01 – 8.21) µg/dL, $p=0.000$] in patients with STE-ACS compared to those with NSTE-ACS. There were significant negative correlations between CKMB (r= -0.438, $p=0.000$) and troponin (r= -0.341, $p=0.000$) with MoCA-Ina score.
Conclusion: There was a lower level of cognitive function in patients with STE-ACS compared to those with NSTE-ACS. Acute intensive managements might be needed to prevent declined cognitive function in ACS.
Keywords: Acute coronary syndrome (ACS), STE-ACS, NSTE-ACS, cognitive function, MoCA-Ina score

INTRODUCTION

Coronary heart disease (CHD) accounts for 7.3 million (45%) of total world deaths[1]. In Indonesia, the prevalence of CHD reached 1.5% in 2013 based on diagnosis and symptoms[2]. Acute Coronary Syndrome (ACS) is one of the clinical manifestations of CHD and often results in death[1,2]. Based on the presence or absence of ST segment elevation, ACS is divided into ACS with ST-elevation (STE-ACS) and Non-ST-elevation ACS (NSTE-ACS). NSTE-ACS consist of unstable angina pectoris (UAP), non-ST elevation myocardial infarction (NSTEMI), while STE-ACS consist of ST-elevation myocardial infarction (STEMI)[3,4].

ACS may be caused by a rapid decrease in coronary artery blood flow caused by acute thrombosis that is induced by the erotion or rupture of coronary atherosclerotic plaque without or accompanied by vasoconstriction.[3,4] An acute total occlusion in the coronary artery might show as a STE-ACS or STEMI, meanwhile an acute non occlussive lession might show NSTE-ACS[3,4].

The decrease in blood flow causes ischemia and even myocardial infarction, resulting in the production of oxidative stress and inflammatory products as well as impaired cardiac function which in turn will directly or indirectly cause brain hypoperfusion and cerebral neurovascular dysfunction.[3,4] Cerebral neural damage that occurs is thought to cause cognitive impairment[3,4,5].

Impairment of cognitive function may be a disorder of the highest cortical noble function (sublime function). This highest noble function is a function that allow human to meet the physical and spiritual needs according to the applied moral values. It is a result of cortical processing function that is a fine integration of each cortical lobus in one hemispher or between hemispheres. This cognitive function includes various specific aspects based on the cognitive domain including memory, attention and concentration, executive function, language, emotion, and visospatial[6].

Impaired cognitive function is closely related to cerebral function because the ability to think will be influenced by the brain. This impairment of cognitive function affects to patients' quality of life, increases neuropsychiatric symptoms, increases disability and health costs[7].

There are several tests that are used to determine a person's cognitive function. The tests that are often used for cognitive function screening are the Mini Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA). MoCA test that has a cut-off point of 26, is showing a sensitivity of 90% in which is higher than MMSE (18%), meanwhile the specificity of MoCA test to detect mild cognitive impairment (MCI) is 87%. The MoCA test is quite high in sensitivity and specificity for MCI examination and only takes a short time, such as approximately 10 minutes[7,8]. MoCA test was adapted in Indonesian language into MoCA-Ina test.

Evaluation of cognitive function is sometimes needed in determining the level of individual functional ability that impacts on the management and prognosis of an illness. However, there were still limited studies that explained differences in cognitive function in the different clinical subset of ACS. It is still not clear whether patients with

STE-ACS will consistently show lower cognitive function values than those with NSTE-ACS. Here, we aimed to study the differences in cognitive function between patients with STE-ACS and patients with NSTE-ACS.

METHODS

This study was an observational analytic study with a cross-sectional study design on differences in cognitive function values between patients with STE-ACS and NSTE-ACS. This study was conducted at the high care unit (HCU) and in-patient ward of Dr. Kariadi hospital, Semarang and Diponegoro National hospital, Semarang from February 2016 to May 2018.

Research subjects were all patients with ACS treated in HCU or in-patient ward of Dr. Kariadi hospital, Semarang and Diponegoro National hospital, Semarang. The inclusion criteria were patients with ACS whose diagnosis had been established with an age range of 25–70 years. Subjects were excluded if the patient had a history of stroke or cerebrovascular disease, head trauma, or intracranial tumor, and had taken drugs that affected the central nervous system (CNS). Samples were selected by consecutive sampling. Data was collected through direct assessment of the subject and medical record data. The Kolmogorov-Smirnov test was conducted to determine the distribution normality of data.

Mann-Whitney test was used to compare the cognitive function values in patients with STE-ACS and in those with NSTE-ACS. Spearman Correlation test was used to find out the correlation between several variables with the cognitive function. Differences were considered statistically significant if the *p* value <0.05.

RESULTS

Table 1 described several baseline characteristics of our study subject. There were no significant differences in several baseline characteristics, except gender, history of dislipidemia, and smoking history. In overal, the average age was 55.7 ± 7.17. The mean age in patients with STE-ACS was 54.8 ± 8.23 and those with NSTE-ACS was 57.0 ± 5.12 (p>0.05). In overal, study subjects were mostly male (n=87 (81.3%)) compared to women (n=20 (18.7%)). However, there was difference in gender distribution between in STE-ACS group (female = 3.7%, male = 55.1%) and NSTE-ACS group (female = 15.0%, male = 26.2%) (p<0.05) (table 1).

In overal, there was higher proportion of patients with dislipidemia history. There was higher proportion of patients with dislipidemia history in STE-ACS group (57%.0) compared to NSTE-ACS group (29.9%) (p<0.05) (table 1).

In our study, most patients with STE-ACS came with comparable onset of ACS, i.e onset >12 hours (30.8%) and onset ≤12 hours (28.0%), while those with NSTE-ACS came with mostly onset ≤12 hours (34.6%) (table 1). This delayed onset in patients with STE-ACS might delay the early management, including reperfusion management, such as primary PCI or thrombolytic therapy. This might represent the real world condition in Indonesian region, both urban and sub-urban area. The possible causes of delayed onset of STE-ACS might be infrastructure condition or community social-education and perceptions. Although we could not yet explain with certainty, some of the late onset in STE-ACS might impact on cardiac performance and hemodynamic which further effect on less cerebrovascular perfusion and lower cognitive function.

In our study, the proportion of patients with recent smoker was not equally distributed in both groups. There was significantly higher proportion of recent smoker in STE-ACS group (35.5%) than in NSTE-ACS group (12.1%) (p=0.007) (table 1)

In our study, the proportion of patients with BMI ≥24 and <24 was not equally distributed in both groups, in which in STE-ACS group (BMI ≥24 (n=32) (29.9%), BMI <24 (n=31) (29.0%)) and in NSTE-ACS (BMI ≥24 (n=12) (11.2%), BMI <24 (n=32) (29.9%), (p<0.05). The BMI of the STE-ACS group was 24.2 (20 – 33) and of the NSTE-ACS group was 21.5 (17.5 – 33), (p<0.05) (table 2).

There was difference in GRACE score between patients with STE-ACS [98.7 ± 22.24; 85 (80 – 144)] and those with NSTE-ACS [90.6 ± 31.82; 80 (60 – 212)], p=0.001 (table 2).

There were no differences in mean fasting blood glucose (FBG), 2 hours post prandial blood glucose (2hPPG), and HbA1c between patients with STE-ACS and NSTE-ACS. However, there was a higher random blood glucose (RBG) in patients with STE-ACS [138 (94–356) mg/dL] compared to NSTE-ACS [126 (82–537) mg/dL] (p=0.05) (table 3).

There was a higher levels of total cholesterol in patients with STE-ACS [170 (126–273) mg/dL] compared to those with NSTE-ACS [159 (127–209) mg/dL] (p<0.05). There was also a higher levels of triglycerides in patients with STE-ACS [171 (79–268) mg/dL] compared to those with NSTE-ACS [106 (63–221) mg/dL] (p<0.05). Morever, there was also a higher levels of LDL-c in patients with STE-ACS [120 (92–192) mg/dL] compared to those with NSTE-ACS [107 (71–172) mg/dL] (p<0.05). There were also higher levels of uric acid (p<0.05), ureum (p<0.05), and creatinine (p<0.05) in patients with STE-ACS compared to those with NSTE-ACS (table 3). Patients with STE-ACS showed higher CKMB (p<0.05) and troponin p<0.05) compared to those with NSTE-ACS (table 3).

In our study, most of patients showed favorable values of ejection fraction (EF) or EF ≥55% [n=93 of 107, (86.9%)]. There was comparable EF between patients with STE-ACS [60.2 ± 5.74; 59 (41 – 69)] and those with NSTE-ACS [56.9 ± 12.44; 62 (21 – 69)] (p>0.05) (table 4).

In our study, most patients showed favorable low risk ACS by TIMI risk stratification, i.e TIMI risk score in patients with STE-ACS (TIMI risk score 0–5 = 84.1%) and in those with NSTE-ACS (TIMI risk score 0–2 = 54.5%) (table 5). There were no differences in proportion of medication administered between both groups, except for MRA (p<0.05) and anticoagulant (p<0.05) (table 6).

Based on intervention performed in 63 patients with STE-ACS, the intervention was differentiated into three types, including primary percutaneus coronary intervention (PPCI), fibrinolytic, and heparinisation. Patients with PPCI were 22 patients (34.9%) and those with fibrinolytic were 9 patients (14.3%). These were patients who came early to our center within <12 hours. While patients with heparinisation alone since the first admission in STE-ACS were 32 patients (50.8%) in which these subjects were also

planned for immediate coronary angiography with stand-by PCI (table 7).

There was significant difference in MoCA-Ina score between patients with STE-ACS (20.8±3.19) and those with NSTE-ACS (23.1±2.47), *p*=0.000 (table 8 and figure 1).

There were no significant differences in MoCA-Ina score between different gender, different background of hypertension, diabetes mellitus, dyslipidemia, or CAD, and history of smoker, *p*>0.05 (table 9).

There were weak negative correlation between uric acid (r= -0.292, *p*=0.002) and creatinine (r= -0.236, *p*=0.015) to the MoCa-Ina score. There were weak negative correlation between CMKB (r= -0.438, *p*=0.000) and troponin (r= -0.341, *p*=0.000) to the MoCA-Ina score by Spearman correlation test. There were also weak negative correlation between TIMI risk score (r= -0.277, *p*=0.004) and GRACE score (r=-0.220, *p*=0.023) to the MoCa-Ina score (table 10).

Table 1: Baseline Clinical Characteristic of Subjects

Characteristic	Diagnosis		Total (N=107)	*P*
	STE-ACS (n=63)	**NSTE-ACS** (n=44)		
Age (years)	54.8 ± 8.23; 56 (41 – 70)	57.0 ± 5.12; 56.5 (47 – 68)	55.7 ± 7.17; 56(41 – 70)	0.161 [d]
Gender				
Female	4 (3.7%)	16 (15.0%)	20 (18.7 %)	
Male	59 (55.1%)	28 (26.2%)	87 (81.3%)	0.000 [a] *
Basic Formal Education: n(%)				0.131 [a]
6 years	13 (12.1%)	4 (3.7%)	17 (15.9%)	
9 years	15 (14.0%)	6 (5.6%)	21 (19.6%)	
12 years	23 (21.5%)	24 (22.4%)	47 (43.9%)	
>12 years	12 (11.2%)	10 (9.3%)	22 (20.6%)	
Onset of ACS (hours)	14.0 ± 10.05;16(3 – 48)	10.4 ± 5.04; 10 (3 – 24)	12.5 ± 8.52; 10 (3 – 48)	0.433 [d]
Onset of ACS				
> 12 hours	33 (30.8%)	7 (6.5%)	40 (37.4%)	
≤ 12 hours	30 (28.0%)	37 (34.6%)	67 (62.6%)	0.000 [a] *
History of Hypertension: n (%)				
Yes	43 (40.2%)	34 (31.8%)	77 (72.0%)	
No	20 (18.7%)	10 (9.3%)	30 (28.0%)	0.307 [a]
History of Diabetes Mellitus (DM)				0.492 [a]
Yes	30 (28.0%)	18 (16.8%)	48 (44.9%)	
No	33 (30.8%)	26 (24.3%)	59 (55.1%)	
History of Dyslipidemia				0.000 [a] *
Yes	61 (57.0%)	32 (29.9%)	93 (86.9%)	
No	2 (1.9%)	12 (11.2%)	14 (13.1%)	
Smoker				0.007 [a] *
Recent smoker	38 (35.5%)	13 (12.1%)	51 (47.7%)	
Ex smoker	11 (10.3%)	13 (12.1%)	24 (22.4%)	
Never smoke	14 (13.1%)	18 (16.8%)	32 (29.9%)	
History of CAD: n (%)				
Yes	33 (30.8%)	18 (16.8%)	51 (47.7%)	0.242 [a]
No	30 (28.0%)	26 (24.3%)	56 (52.3%)	
History of previous PCI: n (%)				
Yes	15 (14.0%)	12 (11.2%)	27 (25.2%)	0.685 [a]
No	48 (44.9%)	32 (29.9%)	80 (74.8%)	

Value was presented in mean ± SD; median (min-max) * statistically significant if *p*<0.05 [a] Chi-square test
[b] Paired *t*-test [c] Independent *t*-test [d] Mann-Whitney

Table 2: Baseline Physical Examination Findings of Subjects

Characteristic	Diagnosis		Total (N=107)	*P*
	STE-ACS(n=63)	**NSTE-ACS**(n=44)		
Systolic blood pressure (SBP) (mmHg)	123.1 ± 26.52;120 (89–200)	129.7±24.26;130(94–171)	125.8 ± 25.70;125(89 – 200)	0.142 [d]
Diastolic blood pressure (DBP) (mmHg)	72.6 ± 16.48; 74(48–110)	78.9 ± 12.46; 80(43–100)	75.2 ± 15.21; 75(43–110)	0.010 [d] *
Mean arterial pressure (MAP) (mmHg)	89.1 ± 18.41; 86 (61– 40)	95.6 ± 15.02; 96 (61–117)	91.8±17.32;91(61–140)	0.018 [d] *
Body weight (kg)	68.4 ± 8.62; 67 (55 – 90)	63.9 ± 11.62; 64(50– 90)	66.5 ± 10.15; 65(50– 0)	0.011 [d] *
Height (cm)	165.3 ± 5.29;165(155 – 178)	163.8± 5.59;165(155–175)	164.7±5.44;165(155–178)	0.287 [d]
Body mass index (BMI) (kg/m^2)	24.5 ± 3.28;24.2(20.0–33.0)	22.9±4.05;21.5(17.5–33.0)	23.8±3.68;22.8(17.5–33.0)	0.002 [d] *
Body mass index (BMI): n (%)				
BMI ≥24 kg/m^2	32 (29.9%)	12 (11.2%)	44 (41.1%)	0.015 [a] *
BMI <24 kg/m2	31 (29.0%)	32 (29.9%)	63 (58.9%)	
Killip	55 (51.4%)	38 (35.5%)	93 (86.9%)	0.234 [a]
I	6 (5.6%)	4 (3.7%)	10 (9.3%)	
II	2 (1.9%)	0 (0%)	2 (1.9%)	

III IV	0 (0%)	2 (1.9%)	2 (1.9%)	
GRACE score				
<109	51 (47.7%)	38 (35.5%)	89 (83.2%)	0.482 [a]
109 – 140	5 (4.7%)	4 (3.7%)	9 (8.4%)	
>140	7 (6.5%)	2 (1.9%)	9 (8.4%)	
GRACE score	98.7 ± 22.24; 85 (80 – 144)	90.6 ± 31.82;80 (60 – 212)	95.4±26.76;85(60–212)	0.001 [d] *
Crusade score				
1 – 20	15 (14.0%)	10 (9.3%)	25 (23.4%)	0.002 [a] *
21 – 30	37 (34.6%)	24 (22.4%)	61 (57.0%)	
31 – 40	0 (0%)	6 (5.6%)	6 (5.6%)	
41 – 50	9 (8.4%)	0 (0%)	9 (8.4%)	
>50	2 (1.9%)	4 (3.7%)	6 (5.6%)	
Crusade score	26.6 ± 10.83;22 (5 – 57)	27.3 ± 12.32; 22 (7 – 63)	26.9 ± 11.41; 22(5– 63)	0.790 [d]

Value was presented in mean ± SD; median (min-max)
* statistically significant if $p<0.05$ [a] Chi-square test [b] Paired *t*-test
[c] Independent *t*-test [d] Mann-Whitney

Table 3: Baseline Laboratory Findings of Subjects

Characteristic	**Diagnosis**		**Total** (N=107)	***P***
	STE-ACS(n=63)	**NSTE-ACS**(n=44)		
Random Blood Glucose (RBG) (mg/dL)	175.6 ± 87.62;138 (94 – 356)	155.1 ± 96.86; 126(82–537)	167.2±91.65;129(82–537)	0.050 [d] *
Fasting Blood Glucose (FBG) (mg/dL)	135.2 ± 51.99; 109 (78– 248)	126.7±62.32;110.5(75– 84)	131.7±56.34;110(75–384)	0.264 [d]
2 hrs PostPrandial Blood Glucose (2hPPG)	165.6 ± 66.59; 29 (75 – 287)	155.4 ± 59.46;140 (89 – 367)	161.4±63.67;130(75–367)	0.980 [d]
HbA1c	6.3 ± 2.09; 5.7 (4.1 – 11.3)	6.1 ± 1.77; 5.5 (4 – 9.6)	6.2 ± 1.96;5.7 (4.0–11.3)	0.603 [d]
Total Cholesterol (mg/dL)	179.8 ± 41.08;170(126–273)	164.1±29.45;159(127 – 209)	173.4±37.41;67(126–273)	0.037 [d] *
Triglycerides (mg/dL)	167.8 ± 46.28;171(79–268)	122.7±44.83; 106 (63 – 221)	149.2±50.64;140(63–268)	0.000 [d] *
HDL-c (mg/dL)	41.1 ± 8.39; 42 (28 – 64)	40.1 ± 10.00; 42 (22 – 65)	40.7 ± 9.05; 42 (22 – 65)	0.585 [d]
LDL-c (mg/dL)	132.4 ± 26.62;120 (92 – 192)	119.9 ± 34.63; 107(71–172)	127.3±30.65 120(71–192)	0.027 [d] *
Uric Acid (mg/dL)	7.0 ± 2.29; 6.5 (3.3 – 12.1)	5.7 ± 2.48; 5.0 (3.1 –12.5)	6.5 ± 2.44; 6.2 (3.1 – 12.5)	0.002 [d] *
Ureum (mg/dL)	39.1 ± 19.60;34 (13.0 – 84.0)	30.8 ± 20.3; 24 (9.0 – 133.0)	35.7±20.22;30(9.0–133.0)	0.005 [d] *
Creatinine (mg/dL)	1.2 ± 0.42;1.2 (0.2 – 2.1)	1.1 ± 0.72; 1.1 (0.4 – 5.1)	1.2 ± 0.56; 1.2 (0.2 – 5.1)	0.026 [d] *
CKMB (U/L)	102.2 ± 78.52; 66 (21 – 292)	35.9 ± 32.25; 22 (10 – 132)	74.9 ± 71.41 52 (10 – 292)	0.000 [d] *
Troponin (µg/dL)\	7.0 ± 7.84; 2.6 (0.01 – 22.22)	0.8 ± 1.88 0.04 (0.01 – 8.21)	4.5 ± 6.84;1.3(0.01– 2.22)	0.000 [d] *

Normal distributed data was presented as mean ± SD; Abnormal distributed data was presented as median (minimum – maximum)
* statistically significant if $p<0.05$ [a] Chi-square test [b] Paired *t*-test [c] Independent *t*-test [d] Mann-Whitney

Table 4: Echocardiographic Findings (n=107)

Characteristic	**Diagnosis**		**Total**	***P***
	STE-ACS (n=63)	**NSTE-ACS (n=44)**		
Ejection fraction:				0.006 [a] *
≥55%	60 (56.1%)	33 (30.8%)	93 (86.9%)	
40 – 49%	3 (2.8%)	7 (6.5%)	10 (9.3%)	
<40%	0 (0%)	4 (3.7%)	4 (3.7%)	
Ejection fraction	60.2 ± 5.74;59 (41 – 69)	56.9±12.44;62(21– 69)	58.8±9.21;61(21–69)	0.765 [d]

Normal distributed data was presented as mean ± SD; Abnormal distributed data was presented as median (minimum – maximum)
* statistically significant if $p<0.05$ [a] Chi-square test [b] Paired *t*-test
[c] Independent *t*-test [d] Mann-Whitney

Table 5. TIMI Score of Patients

Characteristic	n (% of total)
TIMI score	
STE-ACS (n=63)	
0 – 5	53 (84.1%)
6 – 10	10 (15.9%)
11 – 14	0 (0%)
TIMI score	
NSTE-ACS (n=44) 0 – 2	24 (54.5%)
3 – 4	14 (31.8%)
5 – 7	6 (13.6%)

Normal distributed data was presented as mean ± SD; Abnormal distributed data was presented as median (minimum – maximum)
* statistically significant if $p<0.05$
[a] Chi-square test [b] Paired *t*-test [c] Independent *t*-test [d] Mann-Whitney

Table 6: Medication of Subject

Characteristic	Diagnosis		Total (n=107)	*P*
	STE-ACS (n=63)	NSTE-ACS (n=44)		
Aspirin (n, %)				
Yes	63 (58.9%)	44 (41.1%)	107 (100%)	
No	0 (0%)	0 (0%)	0 (0%)	
P2Y12 inhibitor (n, %)				
Yes	63 (58.9%)	44 (41.1%)	107 (100%)	
No	0 (0%)	0 (0%)	0 (0%)	
ACEi or ARB (n, %)				
Yes	48 (44.9%)	34 (31.8%)	82 (76.6%)	0.896 [a]
No	15 (14.0%)	10 (9.3%)	25 (23.4%)	
Beta-blockers (n, %)				
Yes	25 (23.4%)	16 (15.0%)	41 (38.3%)	0.728 [a]
No	38 (35.5%)	28 (26.2%)	66 (61.7%)	
MRA (n, %)				
Yes	4 (3.7%)	15 (14.0%)	19 (17.8%)	
No	59 (55.1%)	29 (27.1%)	88 (82.2%)	0.000 [a]*
Diuretics (n, %)				
Yes	4 (3.7%)	6 (5.6%)	10 (9.3%)	0.203 [a]
No	59 (55.1%)	38 (35.5%)	97 (90.7%)	
Anticoagulant (n, %)				
Enoxaparin	12 (11.2%)	13 (12.1%)	25 (23.4%)	0.003 [a]*
Fundaparinux	31 (29.0%)	29 (27.1%)	60 (56.1%)	
UFH	20 (18.7%)	2 (1.9%)	22 (20.6%)	

ACEi: angiotensin converting enzyme inhibitors; ARBs: angiotensin receptor blockers; MRA: mineralocorticoid-receptor antagonists,
Normal distributed data was presented as mean ± SD; Abnormal distributed data was presented as median (minimum – maximum)
*statistically significant if $p<0.05$ [a] Chi-square test [b] Paired *t*-test [c] Independent *t*-test [d] Mann-Whitney

Table 7: Intervention in Patients with STE-ACS (n=63)

Intervention	n(% of STE-ACS)
Primary PCI	22 (34.9%)
Fibrinolytics	9 (14.3%)
Heparinization	32 (50.8%)

Normal distributed data was presented as mean ± SD;
Abnormal distributed data was presented as median (minimum – maximum)
* statistically significant if $p<0.05$ [a] Chi-square test
[b] Paired *t*-test [c] Independent *t*-test [d] Mann-Whitney

Table 8: MOCA-Ina Score (n=107)

Characte-ristic	Diagnosis		Total
	STE-ACS (n=63)	NSTE-ACS (n=44)	
MOCA-Ina	20.8 ± 3.19; 22 (12–27)	23.1 ± 2.47; 23.5 (18 – 27)	21.7±3.13 ; 22 (12 – 27)

Pvalue 0.000[d]*
Normal distributed data was presented as mean ± SD; Abnormal distributed data was presented as median (minimum – maximum)
* statistically significant if $p<0.05$ [a] Chi-square test
[b] Paired *t*-test [c] Independent *t*-test [d] Mann-Whitney

Figure 1. Difference of MOCA-Ina with STE-ACS and NSTE-ACS

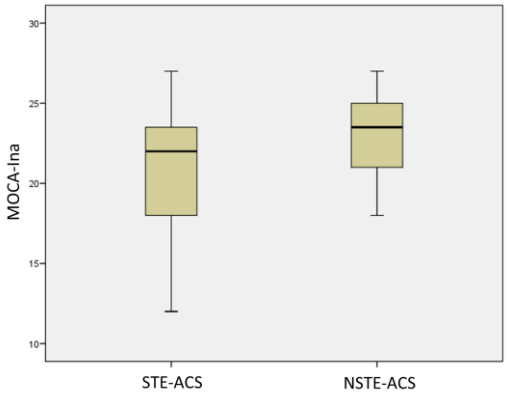

Table 9: MoCA Scores

	MoCA Scores Mean±SD / Median (Min–Max)	*p*
Gender		
Female	21.9 ± 2.88; 21.5 (18–25)	0.584 [d]
Male	21.7 ± 3.20;22 (12–27)	
Hypertension		
Yes	21.9 ± 3.11 ; 22 (12–27)	0.426 [d]
No	21.4 ± 3.21; 22.5 (17–27)	
Diabetes mellitus		
Yes	21.8 ± 3.49; 23.5 (12–27)	
No	21.7 ± 2.82; 22 (17–27)	0.278 [d]
Dyslipidemia		
Yes	21.5 ± 3.21;22 (12–27)	0.087 [d]
No	23.4 ± 1.91;3 (21–27)	
Smoker		
Recent smoker	21.4 ± 3.47; 22 (12 – 27)	
Ex smoker	21.4 ± 2.70; 21.5 (17 – 25)	
Non smoker	22.6 ± 2.75; 23.5 (17 – 27)	0.149 [e]
History of CAD		
Yes	21.4 ± 3.56; 22 (12–27)	0.325 [d]
No	22.1 ± 2.65; 23 (18–27)	

*Statistically significant if $p<0.05$ [b] Independent *t*-test
[d] Mann-Whitney test [e] Kruskal-Wallis test

Table 10:Correlation between some variables with MoCA-Ina score

Variables	Correlation Coefficient	MoCA-Ina Score
Systolic blood pressure	r	0.103
	p	0.290
Diastolic blood pressure	r	0.192
	p	0.048
Mean artery pressure	r	0.145
	p	0.136
Random blood glucose	r	0.014
	p	0.890
Fasting blood glucose	r	-0.069
	p	0.478
2hrs post prandial glucose	r	-0.016
	p	0.874

HbA1c	r	0.005
	p	0.959
Total Cholesterol	r	0.113
	p	0.247
Trigliseride	r	-0.164
	p	0.091
HDL-c	r	0.283
	p	0.003 * [f]
LDL-c	r	-0.260
	p	0.007 * [f]
Uric acid	r	-0.292
	p	0.002 * [f]
Ureum	r	-0.131
	p	0.178
Creatinine	r	-0.236
	p	0.015 * [f]
CKMB	r	-0.438
	p	0.000 * [f]
Troponin	r	-0.341
	p	0.000 * [f]
Killip	r	-0.141
	p	0.148
TIMI	r	-0.277
	p	0.004 * [f]
GRACE score	r	-0.220
	p	0.023 * [f]
CRUSADE score	r	-0.167
	p	0.086
EF	r	0.087
	p	0.371

*Statistically significant if $p<0.05$ [f] Non-parametric Spearman correlation test

DISCUSSION

Our study showed that the cognitive function measured by MoCA-Ina score in all patients with ACS was 21.7±3.13. This value was lower than previous study conducted by Volonghi et al in which they showed that the average MoCA score in patients with ACS was 23.5.[5] This might be due to differences in race, socioeconomics, and/or the education level of our study subjects to the previous study. Previous study was also conducted in England in where most of the population were white race[9].

Elevation in ST segment may indicate acute total coronary thrombotic occlusion. The majority of patients with the initial presentation of ST segment elevation evolved into Q waves in ECG[4,10]. Our study could reveal the difference in cognitive function that was measured by MoCa-Ina score between patients with STE-ACS and those with NSTE-ACS. The cognitive function in patients with STE-ACS [20.8±3.19; 22(12– 7)] was lower than those with NSTE-ACS [23.1±2.47; 23.5(18–27)].

Studies reported that Plasma C-reactive protein (CRP) levels were different between patients with acute myocardial infarction (AMI) with Q waves and patients with AMI without Q waves as well as with patients with stable angina pectoris. The increased CRP levels were associated to the ongoing myocardial damage and to the existing inflammation[11]. Although we did not measure the levels of CRP and other inflammation markers in our study, we hypothesized that inflammation might have role in the impairment of cognitive function.

Inflammation and vascular oxidative stress are the main pathogenesis factors in neurovascular dysfunction. Neurovascular dysfunction makes the brain more susceptible to damage by interfering with regulation of cerebral blood supply or flow, disrupting blood brain barrier function and decreasing the cerebral potential ability to repair from damage resulting in neuron dysfunction and deficits in cognitive function. A study showed that biomarkers of systemic inflammation and hemostasis had a relationship with progressive decline in general or specific cognitive function[12].

Our study also showed that there was a negative correlation between CKMB and troponin with MoCA-Ina scores. This revealed that the higher the CKMB and troponin values, the lower the MoCA-Ina score was obtained. The higher CKMB and troponin values indicated that there might be larger damage or injury in cardiomyocytes.

The myocardial injury or necrosis might impact on systolic or diastolic function. The necrotic myocardium partly might further remodelled and turned into connective tissue in which both would impact on myocardial contractility and function as well as increase the work of healthy myocardium[13,14]. A study showed that CKMB and troponin were directly proportional to inflammation biomarkers CRP, so that the higher CKMB and troponin the higher the inflammatory reaction that occured[15]. It seemed that inflammation also played a role in impaired cognitive function[11].

In our study, there were favorable EF in most of study subjects, in which 86.9% of patients with ACS showed EF ≥55%. Meanwhile, there was a comparable EF in patients with STE-ACS [60.2 ± 5.74; 59 (41 – 69)] and in those with NSTE-ACS [56.9 ± 12.44; 62 (21–69)].

The favorable EF of ≥55% in our study might be caused by the low risk ACS subset in most of our study subjects. Furthermore, normal EF did not solely indicate that the left ventricle was functioning properly. Patients with diastolic dysfunction sometimes have normal EF but show left ventricular diastolic dysfunction, such as the inability to normally stretch, relax, and fill. This impaired ventricular relaxation caused by ischemia might effect on ventricles stiffness, impaired filling time, and increased diastolic pressure.[16] Previous studies had shown that diastolic heart failure could also decrease patients' cognitive function, especially in the attention and execution domains, although it was not as severe as in patients with systolic heart failure[17].

Our study showed that the cognitive function in female patients was comparable than in men. This were different to previous study conducted by Onadja et al which revealed that women had showed higher impairment in cognitive function than men[18].

Our study could not show that hypertension and diabetes mellitus might impact on cognitive function. This was different to previous study conducted by Goldstein et al[19] and Luchsinger et al[20]. Goldstein et al showed that patients with hypertension had significant decline in cognitive function compared to normotension,[19] while Luchsinger et al revealed that patients with DM were more likely to experience cognitive decline than those who without DM[20].

Our study showed that the majority of subjects had dyslipidemia status. Previous study which revealed that patients with dyslipidemia had the incidence of mild cognitive impairment compared to those without[21].

Our study could not show different cognitive function

between patients with or without smoking history. It was similar to study conducted by Sabia et al which showed that male smokers experienced cognitive decline in the global cognitive and the execution functions in comparison with those who have never smoked. Moreover, the former smokers who quited for more than 10 years showed no adverse effects on cognitive function[22].

Our study had several limitations. Our study design was only cross-sectional that could not show causal relationship between research variables. We could not elucidate the impact of the location and number of culprit and non-culprit coronary arteries lession to the patients' cognitive function value.

We still need further studies with larger number of subjects and longer duration, or with a cohort study design to determine the cognitive function impairment between patients with STE-ACS and those with NSTE-ACS. We need further study to determine the effect of the number and location of culprit and non-culprit coronary arteries lession that might impact on cognitive function.

CONCLUSION

Patients with STE-ACS showed a lower cognitive function values than those with NSTE-ACS. Acute intensive managements might be needed to prevent declined cognitive function in ACS.

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