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Assess the Correlation Between Electroencephalogram, National Institutes of Health Stroke Scale and Montreal Cognitive Assessment in Patients with Acute Ischemic Stroke

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Abstract

Background: Stroke severity can be assessed by montreal cognitive assessment (MoCA) for the cognitive outcome and by the national institutes of health stroke scale (NIHSS) for the functional outcome. Moreover, quantitative electroencephalography (qEEG) can detect any subtle changes in brain metabolism which could be used for severity assessment. This study aimed to identify the association between qEEG with severity by NIHSS and MoCA in acute ischemic stroke.

Methods: A cross-sectional study recruited patients with acute ischemic stroke who were hospitalized at neurological ward. A total of 25 cases were investigated. All data were collected included age, sex, history of comorbidity, alberta stroke programme early CT score (ASPECTS), NIHSS, Indonesian version of MoCA (MoCA-Ina), and qEEG parameter. Initial stroke severity was assessed by NIHSS and MoCA-Ina. The qEEG parameters were shown in the form of absolute power.

Results: Most patients aged > 51 years, male more than female. There were no differences regarding age, sex, and ASPECTS based on NIHSS and MoCA-Ina score. However, cases with morbidity had lower median score of NIHSS than those without ($p = 0.039$). There were no differences in qEEG parameters based on NIHSS group. However, based on grouping of MoCA-Ina score, patients with cognitive impairment had higher δ-absolute power than those with normal cognitive functioning ($p = 0.01$). We found that δ-absolute power was independently associated with MoCA score, but not with NIHSS ($p < 0.001$).

Conclusions: qEEG parameters had significant correlation with initial stroke severity in acute ischemic stroke patients. δ-absolute power, and ratios negatively correlated with MOCA-Ina score. The use of qEEG for detecting initial stroke severity may help clinicians to plan better management to prevent the worsening outcome of stroke.

Keywords: Quantitative electroencephalography, National institutes of health stroke scale, Montreal cognitive assessment, Acute ischemic stroke, δ-absolute power

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Introduction

Stroke severity at onset can affect outcomes, including mortality, treatment duration, stroke progression and functional healing [1]. It is a potential and significant outcome predictors improvement when stroke severity detecting as early as possible. Improvements in the assessment of initial stroke severity can result in more specific management of rehabilitation and can provide clearer data for cases and their families. Different previous studies used primer stroke assessments with the NIHSS as a predictor of neurological functional outcomes [2].

NIHSS has been validated and commonly used to measure both the initial stroke severity and the treatment outcomes [3]. Several scale items need intact language function, thus the NIHSS is overweight deficit in cases with left versus right brain strokes. Left hemisphere strokes score four more points than right hemisphere stroke of similar size [4].

The severity initial assessment of cognitive impairment uses paper-based assessments, including the MoCA or mini-mental state examination (MMSE). Assessment of cognitive function with MoCA is more suggested for cognitive disorders post stroke because the examination is more sensitive to diagnose mild impairment compared with the MMSE examination [5]. The test administration of MoCA was applicable in patients with mild-to-moderate stroke, either acute ischemic or hemorrhagic strokes and TIA [6, 7].

Recently, aphasia and hemiplegia can preclude the use of the MoCA to assess global cognitive impairment, in addition to hearing loss and visual impairment [8].

qEEG can detect changes in CBF and brain metabolism in 28 to 104 seconds [9]. When normal CBF declines to 25 - 35 ml/100 g/min, the EEG loses its faster frequencies, then as the CBF decreases to 17 - 18 ml/100 g/min, the slower frequencies gradually rise. This represents a crucial ischemic threshold at which neurons start to lose their transmembrane gradients, leading to cell infarction [10].

qEEG is a powerful tool for predicting the degree of functional disability and cognitive impairment post-acute ischemic stroke events [11, 12].

The present study aims to identify the correlation between qEEG severity assessed by NIHSS and MoCA in acute ischemic stroke.

Methods

Study design and sitting

A cross-sectional study recruited patients with acute ischemic stroke who were hospitalized at neurological ward.

Inclusion criteria

- Acute ischemic stroke.
- Aged ≥ 18 years old.
- Cooperative.

Exclusion criteria

- Unconscious.
- Previous seizure.
- Infratentorial lesions.
- Brain tumor.
- Intracranial infection.
- Traumatic brain injury.
- Depression.
- Dementia.
- Aphasia or dysphasia.
- Electrolyte imbalance.
- Antidepressant, benzodiazepine, and/or psychotropic drugs.
- Pre disability stroke onset.

All participants signed a written informed consent form prior to the investigation. A total of 25 cases were investigated.

Data collection

All data were collected included age, sex, history of comorbidity, ASPECTS, NIHSS, MoCA-Ina, and qEEG parameter [13]. Initial stroke severity was assessed by NIHSS and MoCA-Ina. NIHSS score (0 - 42, with score of < 5 categorized as minor stroke, score of ≥ 6 categorized as moderate to severe stroke) [14]. MoCA-Ina total score (30, score of < 23 categorized as having cognitive impairment, score of ≥ 23 categorized as normal cognitive functioning) [15]. The qEEG parameters were shown in the form of absolute power. qEEG examination was performed within resting conditions. Examination was only done with the eyes closed [16].

Statistical analysis

All statistical analyses were assessed by SPSS software version 25.0 (IBM Co. Ltd, NY, USA). We used independent t-test (for continuous variables), and chi-square test (for categorical variables). For investigating the correlation between qEEG parameters with NIHSS and MoCA-Ina, we performed Spearman correlation. A $p < 0.05$ in indicated as statistical significance.

Results

Table 1 shows demographic and clinical characters based on NIHSS and MoCA-Ina score. Most patients aged > 51 year, male more than female. There were no differences regarding age, sex, and ASPECTS based on NIHSS and MoCA-Ina score. However, cases with morbidity had lower median score of NIHSS than those without ($p = 0.039$).

Table 2 shows the qEEG parameters based on the categorization of NIHSS and MoCA-Ina. There were no differences in qEEG parameters based on NIHSS group. However, based on grouping of MoCA-Ina score, patients with cognitive impairment had higher δ-absolute power than those with normal cognitive functioning ($p = 0.01$).

A multivariate regression analysis is listed in table 3. We found that δ-absolute power was independently associated with MoCA score, but not with NIHSS ($p < 0.001$).

Table 1: Distribution based on NIHSS and MoCA-Ina.

Characters		Total (n)	NIHSS		MoCA-Ina	
			Median	p	Median	p
Age	< 50	10	4	0.4	21	1
	> 51	15	5		22	
Sex	Male	15	4	1	23	0.4
	Female	10	4		21	
Comorbidity	Yes	23	4	0.039	21	0.5
	No	2	8		22	
ASPECTS	High	5	5	1	22	0.6
	Low	20	4		21	

Table 2: qEEG parameters based on the categorization of NIHSS and MoCA-Ina.

Parameters	NIHSS			MoCA-Ina		
	Minor (n = 8) (median)	Severe (n = 17) (median)	p	Cognitive impairment (n = 17) (median)	Normal (n = 8) (median)	p
δ	2150.4	1688.5	0.1	2520.8	1444.6	0.01
θ	750.4	373.9	0.2	508.8	589.1	0.9
α	550.3	417.9	0.9	292.1	706.4	0.7
β	118.6	142.1	0.2	213.3	241.6	0.8

Table 3: Multivariate regression analysis.

Variables	NIHSS		MoCA-Ina	
	B	95% CI	B	95% CI
Age	0.032	(-0.06 - 0.14)	0.067	(-0.21 - 0.08)
Sex	0.374	(-2.76 - 2)	1.833	(-1.27 - 4.94)
Comorbidity	2.736	(-7.47 - 1.2)	6.395	(-12.6 - -0.22)
ASPECTS	0.5	(-1.4 - 0.4)	0.017	(-1.15 - 1.18)
δ	0.272	(-0.81 - 1.36)	2.887	(-4.3 - -1.5)
θ	0.885	(-3.65 - 1.88)	3.258	(-0.35 - 6.9)
α	0.966	(-1.31 - 3.24)	0.482	(-3.45 - 2.49)
β	0.883	(-7.81 - 6.04)	0.504	(-9.53 - 8.53)

Discussion

In this work, there was a positive correlation between qEEG and NIHSS while negative correlations were found between δ-absolute power with MOCA-Ina score. EEG may reflect changes in cerebral blood flow (CBF) and metabolism within seconds as these are directly reflected in the neuronal rhythms [17].

Prior study showed that δ activity may be related to the core ischemic region, meanwhile θ and α activity are possibly related to the ischemic penumbra, flow diaschisis and cerebral edema [18]. θ power over the affected hemisphere correlated with plasmatic peroxide level

as a marker of oxidative stress and δ power was negatively correlated with transferrin, presumed to act as a free radical scavenger in acute ischemic stroke. These findings suggest that neurophysiological signals may reflect the biological processes underlying the pathophysiology of stroke. Using magnetoencephalography in ischemic stroke cases in the middle cerebral artery territory, it was shown that δ-absolute power over the affected hemisphere was independently associated with clinical status measured by the NIHSS score [19].

There is an observation of rapid diminution of EEG δ wave pathophysiology following the commencement of thrombolytic therapy [20]. Previous studies showed that δ power, α power, delta/alpha power ratio and (delta + theta)/(alpha + beta) ratio (DTABR) were correlated with clinical and functional outcomes of stroke [21], and that α power as well as DTABR could serve as predictors for post-stroke outcome [22].

In addition to NIHSS, prior studies demonstrated that qEEG parameters could also be used to detect cognitive impairment in acute stroke patients. In the present study, we showed that δ-absolute power was negatively correlated with cognitive function. The findings were in accordance with a previous study which was conducted using single channel EEG for measuring cognitive function after stroke. It was revealed that relative power θ, relative power δ, and ratios were correlated with the MoCA score at 90 days after stroke [23]. Greater relative power of θ was associated with better cognitive outcomes; while greater values of δ, and ratios were associated with poorer cognitive outcomes [24].

After controlling covariates, we found that δ power was a significant factor associated with cognitive impairment in acute stroke. Raised δ power was correlated with reductions in CBF and neuronal metabolism during focal ischemia [8], which may lead to cognitive dysfunction. Furthermore, abnormal δ power could impair attention in post-stroke [25, 26] and correspond with drop global cognitive function in many disease states [27, 28].

These findings may help to advance future studies investigating qEEG parameter for predicting the functional and cognitive outcome of post-stroke and be useful in clinical practice.

Conclusion

Several qEEG parameters had significant correlation with initial stroke severity in acute ischemic stroke patients. Δ absolute power, and ratios negatively correlated with MOCA-Ina score. The use of qEEG for detecting initial stroke severity may help clinicians to plan better management to prevent the worsening outcome of stroke.

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None.

Conflict of Interest

None.

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