

A Study on the Relationship between CBC and EEG for Epilepsy Patients

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뇌전증 EEG결과와 CBC결과의 관계연구

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Epilepsy is a disorder that causes recurring seizures, and the most objective and useful test for detecting epilepsy is the electroencephalogram (EEG). The subjects of this study are 244 patients who received an EEG after being diagnosed with epilepsy at Seoul National University Hospital in 2014, and who have agreed to the purpose of the study. Based on the EEG results, subjects were divided into normal and abnormal groups with 122 subjects in each group, regardless of their gender and age, to investigate the correlation of EEG and complete blood cell count (CBC) test results. The four significant categories that displayed significant correlation between EEG results and CBC hematological measurements in this study were the white blood cell (WBC), red blood cell (RBC), neutrophil, and lymphocyte tests. The WBC ($p < 0.05$) and neutrophil ($p < 0.01$) showed a positive correlation with EEG results, while RBC ($p < 0.05$) and lymphocyte ($p < 0.01$) showed a negative correlation. One of the limitations of this study is that it is lacking the blood test result analysis according to the types of anti-epilepsy medicine. However, the analysis of EEG results by the same disease has significant meaning. Therefore, further studies are needed to statistically analyze more data in the future.

Keywords: Complete blood cell count, Electroencephalogram, Epilepsy

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Introduction

Epilepsy is a disorder that causes recurring seizures, and various brain diseases are risk factors or causes of epilepsy (Shorvon, 2011). Epilepsy seizure occurs unpredictably, which disables the doctor to observe the symptoms directly during the doctor's appointment. Thus, a medical history through the patient or the guardian is highly important (Noachtar & Rémi, 2009). Electroencephalogram (EEG) is the

most objective and useful test for epilepsy (Pillai & Sperling, 2006). Particularly, it is reported that the appearance of EEG wave during an EEG increases the risk of epilepsy more than 5 fold (Kim *et al.*, 2013). This result can be confirmed in various studies (Annegers *et al.*, 1986; Hauser *et al.*, 1990; Shinnar *et al.*, 1990, van Donselaar *et al.*, 1992). However, there are cases where EEG waves were not found in EEG of epilepsy (Theodore *et al.*, 1984) or where EEG waves were found in patients with no epilepsy seizure (Park, 2007). Thus,

seizure in epilepsy patients is currently being treated based on each doctor's personal experience (Pearce & Cock, 2006; Askamp & van putten, 2013). Therefore, the purpose of this study is to investigate the correlation between EEG results and complete blood cell count (CBC) test results in subjects who were diagnosed for epilepsy and to use the analyzed results for clinical baseline data.

Materials and Methods

1. Subjects

The subjects of this study were 244 patients who received an EEG at Seoul national university hospital in 2014 and who agreed to the research purposes of the study. Subjects were divided into normal and abnormal group of 122 patients according to the EEG results, regardless of their gender and age. It was approved by the institutional review board (IRB Approval Number: H-1504-094-666).

2. Anthropometric measurements and blood test

Anthropometric measurements were obtained using an automated anthropometric instrument by the nurses, and an automatic blood cell analyzer was used to test white blood cell (WBC), red blood cell (RBC), hemoglobin (Hb), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell volume distribution width (RDW), platelet (PLT), platelet crit (PCT), mean platelet volume (MPV), neutrophil segment, lymphocyte, monocyte, and eosinophil for CBC test at the Department of Laboratory Medicine.

3. EEG

EEG was conducted using Comet at a sample frequency of 200 Hz, frequency filter at maximum 70 Hz and minimum 1.0 Hz, sensitivity of 150 μ V/pp, and AC resistance below 10 k Ω .

4. Statistical analysis

Statistical analysis was performed using the SPSS (PC, Version 21.0) program. A frequency analysis and mean (M) and standard deviation (SD) were calculated for the physical features, CBC results, and EEG test results of the subjects. An independent *t*-test was performed for analysis of differences, and a correlation analysis was performed for relational analysis. All statistical significance level was set as $p < 0.05$.

Results

1. General characteristics of EEG result group

This study investigated 244 patients who were diagnosed for epilepsy with 128 being males and 116 females. The average age of the 122 subjects in the normal group appointed by the EEG results was 57.84 ± 15.08 and the average age of the abnormal group was 54.01 ± 18.98 . The average height of the normal group was 160.99 ± 18.64 and 162.01 ± 12.83 for the abnormal group, and the average weight of the normal group was 65.61 ± 15.39 and 62.40 ± 17.40 for the abnormal group. The average systolic blood pressure of the normal group was 117.06 ± 23.58 and 116.79 ± 20.50 for the abnormal group, and the average diastolic blood pressure was 72.46 ± 13.86 in the normal group and 71.66 ± 13.87 in the abnormal group. The two groups appeared as composing equal subjects as there was no significant difference in age,

Table 1. General characteristics of EEG result group

Character	Total N=244	Normal group N=122	Abnormal group N=122	F/t
		M \pm SD		
Age	55.92 \pm 17.21	57.84 \pm 15.08	54.01 \pm 18.98	16.84 [†] /1.74
Height (cm)	161.50 \pm 15.98	160.99 \pm 18.64	162.01 \pm 12.83	.12/- .50
Weight (kg)	64.00 \pm 16.47	65.61 \pm 15.39	62.40 \pm 17.40	.28/1.52
SBP (mmHg)	116.92 \pm 22.05	117.06 \pm 23.58	116.79 \pm 20.50	.86/.09
DBP (mmHg)	72.06 \pm 13.83	72.46 \pm 13.83	71.66 \pm 13.87	.12/.45

Abbreviation: SBP, systolic blood pressure; DBP, diastolic blood pressure.

[†] $p < 0.01$.

height, weight, systolic blood pressure, and diastolic blood pressure (Table 1).

2. CBC results by EEG result group

The difference in CBC test results in the normal group and abnormal group according to the EEG results was shown by several variables. The average WBC in the normal group was 6.30 ± 2.06 and 6.91 ± 2.48 in the abnormal group, with the abnormal group showing a significantly higher value ($p < 0.05$). The average RBC in the normal group was 4.42 ± 0.50 and 4.25 ± 0.59 in the abnormal group, with the normal group showing a significantly higher value ($p < 0.05$). The average neutrophil level in the normal group and abnormal group was 54.36 ± 12.50 and 59.68 ± 12.97 , respectively, with the abnormal group showing significantly higher value ($p < 0.01$). The average lymphocyte level in the normal group and abnormal group was 34.63 ± 11.53 and 29.25 ± 11.64 , respectively, with the abnormal group being significantly

higher ($p < 0.01$) (Table 2).

3. Correlation analysis of EEG results and CBC results

According to a correlation analysis of EEG results and CBC results of the subjects, WBC showed a positive correlation ($p < 0.05$) to any problems in the EEG wave, while RBC showed a negative correlation ($p < 0.05$). Neutrophil showed a positive correlation ($p < 0.05$), while lymphocyte showed a negative correlation ($p < 0.01$) (Table 3).

4. Regression analysis of EEG results and CBC results

WBC values showed a positive correlation to EEG results with a *t* value of 2.09 ($p < 0.01$), which is affected under a statistically significant level. The correlation to RBC was negative, with a *t* value of -2.39 ($p < 0.05$), which is affected at a statistically significant level, and the *t* value of neutrophil was 2.12 ($p < 0.01$), showing a positive correlation to EEG results and being affected at a statistically significant level.

Table 2. Results of CBC by EEG Result group

Variable	Total N=244	Normal group N=122	Abnormal group N=122	F/t
	M±SD			
WBC (mm ³)	6.60±2.30	6.30±2.06	6.91±2.48	1.94/-2.09*
RBC (million/mm ³)	4.33±0.55	4.42±0.50	4.25±0.59	3.88/2.39*
Hb (g/dL)	13.30±1.92	13.47±1.83	13.13±1.99	1.11/1.35
HCT (%)	39.84±5.08	40.42±4.79	39.26±5.31	1.44/1.79
MCV (fL)	92.12±6.25	91.68±7.02	92.56±5.35	1.75/-1.09
MCH (pg)	30.72±2.59	30.53±2.90	30.92±2.23	1.53/-1.18
MCHC (%)	33.32±1.32	33.25±1.37	33.39±1.27	.14/- .79
RDW (%)	13.29±1.52	13.29±1.57	13.29±1.47	.00/- .02
PLT (thousand/mm ³)	220±72.92	224.52±72.60	215.53±73.26	.02/.96
PCT (%)	0.21±0.06	0.21±0.06	0.21±0.06	1.67/.76
PDW (%)	12.08±3.24	327.12±784.70	70.88±34.99	.06/.98
Neutrophil (%)	57.02±12.98	54.36±12.50	59.68±12.97	.12/-3.26 [†]
Lymphocyte (%)	31.94±11.87	34.63±11.53	29.25±11.64	.08/3.62 [†]
Monocyte (%)	7.59±2.23	7.37±2.03	7.80±2.41	2.32/-1.49
Eosinophil (%)	2.69±2.42	2.76±2.21	2.61±2.62	2.09/.46

Abbreviation: WBC, white blood cell; RBC, red blood cell; Hb, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; RDW, red cell volume distribution width; PLT, platelet; PCT, platelet crit; MPV, mean platelet volume.
* $p < 0.05$, [†] $p < 0.01$.

Table 3. Correlation of EEG result and CBC

	WBC	RBC	Neutrophil	Lymphocyte
EEG Result	.13*	-.15*	.21 [†]	-.23 [†]

Abbreviation: EEG, electroencephalogram.
* $p < 0.05$, [†] $p < 0.01$.

Table 4. Relation of EEG result and CBC

	EEG Result					
	β	SE	t	p	D-W	R/R ² /F
WBC	.61	.29	2.09	.00 [†]	2.00	.13/.02/4.39*
RBC	-.17	0.07	-2.39	.02*	1.98	.02/.02/5.74*
Neutrophil	5.32	1.63	3.26	.00 [†]	2.12	.04/.04/10.65 [†]
Lymphocyte	-5.37	1.48	-3.62	.00 [†]	2.09	.05/.05/13.12 [†]

Abbreviation are the same as those in Table 2, 3.

* $p < 0.05$, [†] $p < 0.01$.

The correlation to lymphocyte was negative, with a t value of -3.62 ($p < 0.01$), which is affected at a statistically significant level. The R^2 value of the variable with statistical significance in the WBC (0.02), RBC (0.02), neutrophil (0.04), lymphocyte (0.05) (Table 4).

Discussion

The purpose of this study was to investigate the correlation between EEG waves and the results from CBC tests in 244 patients who were diagnosed for epilepsy. The 4 categories that displayed a significant correlation between EEG results and CBC blood test results were WBC, RBC, neutrophil, and lymphocyte, where WBC ($p < 0.05$) and neutrophil ($p < 0.01$) showed a positive correlation, while RBC ($p < 0.05$) and lymphocyte ($p < 0.01$) showed a negative correlation. One of the limitations of this study is that it did not take in consideration of the medicine the patients would take for treatment of epilepsy, as anti-epilepsy treatments are known to induce hematological side effects, causing aplastic anemia, leukopenia, thrombopenia, megaloblastic anemia, etc. (Son *et al.*, 2013). Epilepsy patients have fatigue is 44% (Ettinger *et al.*, 1998). Antiepileptic of osteopenia and osteoporosis observed by measuring the marker that indicates the activity of osteoclasts and osteoblasts in the blood and urine to generate a result, the enzyme-induced antiepileptic reduces the blood calcium and vitamin D to increase the bone-specific Alkaline phosphatase (ALP) levels and, it promotes bone turnover (Yu, 2008). However, all of the subjects in this study are patients who were diagnosed for epilepsy and who were taking certain anti-epilepsy medicines. Patients who were taking anti-epilepsy medicines and had abnormal EEG waves showed a positive correlation to WBC ($p < 0.05$) and neutrophil

($p < 0.01$), but a negative correlation to RBC ($p < 0.05$) and lymphocyte ($p < 0.01$). These statistically significant results are highly meaningful, and suggest further studies for statistical analysis of larger amount of data.

요약

뇌전증은 반복적으로 발작이 발생하는 질환으로, 뇌파검사가 가장 객관적이고 유용한 검사이다. 본 연구의 대상자는 2014년 서울대학교 병원에서 뇌전증 확진판정을 받고 뇌파 검사를 받은 환자를 대상으로 연구목적에 동의한 244명을 대상으로 하였다. 이 중 뇌파 검사결과에 따라 성별과 연령에 상관없이 정상그룹 122명, 비정상 그룹 122명을 대상으로 뇌파소견과 혈구산정검사와의 상관관계를 알아보고자 하였다. 이번 연구에서 분석된 뇌파 측정결과와 혈구산정검사 결과와의 유의한 상관관계는 WBC, RBC, neutrophil, lymphocyte로 4항목이었다. WBC ($p < 0.05$)와 neutrophil ($p < 0.01$)은 양의 관계였으며, RBC ($p < 0.05$)와 Lymphocyte ($p < 0.01$)는 음의 관계로 나타났다. 이 논문의 한계점은 항뇌전증 치료제의 종류에 따른 혈구산정 검사결과를 분석하지 못한 것이다. 하지만 동일한 질환에 따른 뇌파결과를 중심으로 분석한 결과는 의미가 있다. 그러므로 이러한 부분은 향후 더욱 많은 데이터를 통계적으로 분석해야 할 필요성이 있다고 생각된다.

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