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Original Article

Clinically Significant Cardiac Arrhythmia in Patients with Aneurysmal Subarachnoid Hemorrhage

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Objective : Many previous studies have shown that electrocardiographic (ECG) changes occur patients with subarachnoid hemorrhage (SAH). This study was designed to identify the frequency, influencing factors, and outcome of clinically significant cardiac arrhythmias after SAH.

Methods : We retrospectively analyzed clinical data of 122 patients including ECG finding, age, sex, the Hunt-Hess grade, the Fisher's grade, the history of hypertension, peak blood pressure and heart rate, location of aneurysm, Glasgow Outcome Scale (GOS) score, the days of admission to the intensive care unit, the presence of symptomatic vasospasm.

Results : Of 122 SAH patients, 50% (n = 61) had a verified clinically significant arrhythmia. There were no statistically significant independent factors associated with clinically significant arrhythmia in multivariate analysis. Although adjustments for the effects of age, Hunt-Hess grade, and the presence of symptomatic vasospasm on death were made, clinically significant arrhythmias were still independently predictive of death (no arrhythmia versus arrhythmia, 11.5% versus 27.9%, adjusted odds ratio [OR] 3.524, 95% confidence interval [CI] 1.229-10.100, $p = 0.019$) and poor outcome (GOS ≦ 2, 13.1% versus 29.5%, adjusted OR 3.202, 95% CI 1.174-8.732, $p = 0.023$).

Conclusion : Clinically significant arrhythmias after SAH are associated with a high mortality rate, and serious cardiac and neurological comorbidity. Patients with an abnormal ECG on admission should undergo close cardiac monitoring, and the presence of rhythm disturbances should prompt aggressive measures to treat myocardial infarction (MI), maintain a normal cardiac rhythm, and minimize the presence of autonomic stress.

Keywords Arrhythmia, Death, Subarachnoid hemorrhage

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INTRODUCTION

Many previous studies have shown that electrocardiographic (ECG) changes occur patients with subarachnoid hemorrhage (SAH). The prevalence of ECG changes in SAH patients is known to vary.[2)5)12)17-19)] Most of these ECG changes, such as sinus arrhythmias, are benign.[4)6)] Only 1–4% of SAH patients have clinically significant arrhythmias, such as atrial tachyarrhythmia, ventricular tachycardia.[1)5)7-9)] Influencing factors of clinically significant cardiac arrhythmias and their impact on clinical outcome is relatively unknown. In this study, we aimed at determining the frequency, influencing factors, and impact on outcome of cardiac arrhythmias after SAH.

MATERIAL AND METHODS

From January 2006 to december 2011, 535 patients

presented with SAH. Among them, 122 patients who fulfilled following criteria were selected for the present study. : (1) treatment of aneurysmal SAH by single center and by a single neurosurgeon; (2) no history of heart disease (ischemic heart disease, congenital heart disease, or other causes); and (3) no surgical complications causing neurological deficit.

We collected clinical data including ECG findings, age, sex, history of hypertension, the Hunt-Hess (H-H) grade (I-V), the Fisher's grade (1-4), peak blood pressure (systolic and diastolic) and heart rate during the 3 days following SAH, location of aneurysm (anterior cerebral artery and anterior communicating artery; middle cerebral artery; internal carotid artery; posterior cerebral circulation; unknown origin), Glasgow Outcome Scale (GOS, 1-5), duration of the intensive care unit (ICU) management, presence of symptomatic vasospasm. We designated that clinically significant arrhythmia was any rhythm disturbance except sinus tachycardia, sinus bradycardia, or a sinus rhythm with premature atrial or ventricular complexes. The patients were divided into two groups on the basis of the presence or absence of clinically significant arrhythmia in SAH. We studied the differences in clinical factors between the two groups and analyzed the determinants that influenced presence or absence of clinically significant arrhythmia.

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 19.0. The *chi-square* test, and *t*-test were performed to evaluate generalized relationships between the factors and the presence of clinically significant arrhythmia. Logistic regression analysis was performed to determine the influence of each factors on the presence of clinically significant arrhythmia. Multivariate model was used to examine the effects of clinically significant arrhythmia on death and poor outcome, after controlling for other predictors of outcome including age, H-H grade, and the presence of symptomatic vasospasm. The results were presumed significant at $p < 0.05$.

RESULTS

Of the 122 SAH patients enrolled in our database, and after excluding patients with sinus bradycardia, sinus tachycardia or sinus rhythm with or without premature ventricular or apical complexes, 50% (n = 61) of patients had a verified clinically significant arrhythmia. Among this group the mean age was 58 years (range: 24–84 years), and 62% were women. The most common type of arrhythmia was non specific ST-T changes and left ventricular hypertrophy (LVH) (Table 1).

The relationships between the factors and the presence of clinically significant arrhythmia are summarized in Table 2. Statistically significant differences were not detected between no arrhythmia group and arrhythmia gruop in age, sex, H-H grade, Fisher's grade, HTN, ICU hospital period, symptomatic vasospasm, peak heart rate and peak systolic pressure except peak diastolic pressure, location of aneurysm. Multivariate analysis showed no significant association of various factors with clinically significant arrhythmia (Table 3).

Adjusted for the effects of age, Hunt-Hess grade, and the presence of symptomatic vasospasm on death

Table 1. Type of clinically significant arrhythmia among 61 patients with subarachnoid hemorrhage

Arrhythmia	N	%
Non specific ST-T change	18	29.5
Left ventricular hypertrophy	17	27.9
Right bundle branch block	7	11.5
Atrial fibrilaion	4	6.6
QT prolongation	3	4.9
T inversion	3	4.9
Tall T wave	3	4.9
Atrioventricular block	2	3.3
Atrioventricular dissociation	1	1.6
Left bundle branch block	1	1.6
Right ventricular hypertrophy	1	1.6
ST elevation	1	1.6

N = Number

Table 2. The relationship between clinically significant arrhythmia and factors

Factors	No arrhythmia (n = 61)	Arrhythmia (n = 61)	*P*-value	OR	95% CI
Peak heart rate	118.77 ± 26.75	120.87 ± 26.20	0.662		
Peak systolic pressure	153.77 ± 16.55	153.61 ± 21.14	0.962		
Peak diastolic pressure	84.75 ± 19.29	75.08 ± 24.87	0.018*		
Age (below 65/above 65)	43/18	39/22	0.440	1.348	0.631 - 2.878
Sex (F/M)	41/20	38/23	0.570	1.241	0.589 - 2.612
Hunt-Hess grade (III-V/I-II)	35/26	36/25	0.854	0.935	0.455 - 1.920
Fisher's grade (3-4/1-2)	58/3	59/2	0.648	0.655	0.106 - 4.067
Hypertension (Y/N)	18/43	21/40	0.560	0.797	0.372 - 1.710
ICU hospital period (below /above 7day)	25/36	29/32	0.466	0.766	0.374 - 1.568
Symptomatic vasospasm (Y/N)	5/56	10/51	0.168	0.455	0.146 - 1.422
Location of aneurysm					
ACA and A-com	23	19	0.109		
MCA	14	19			
ICA	21	17			
PC	0	5			
Unknown origin	3	1			

*$p < 0.05$
F = female; M = male; Y = yes; N = no; GOS = Glascow outcome scale; ICU = intensive care unit; OR = odds ratio; CI = confidence interval; ACA = anterior cerebral artery; A-com = Anterior communicating artery; MCA = middle cerebral artery; ICA = internal carotid artery; PC = posterior circulation; n = number

Table 3. The determinants associated with clinically significant arrhythmia

	OR	*p*-value	95% CI
Hunt-Hess grade (III-V/I-II)	1.410	0.420	0.612 - 3.251
Age (below 65 / above 65)	1.464	0.386	0.618 - 3.470
Symptomatic vasospasm (Y/N)	0.346	0.096	0.099 - 1.206
Sex (F/M)	1.367	0.464	0.593 - 3.153
Fisher's grade (3-4/1-2)	0.812	0.831	0.120 - 5.492
Hypertension (Y/N)	0.614	0.260	0.262 - 1.435
ICU hospital period (below / above 7day)	0.823	0.643	0.361 - 1.876

*$p < 0.05$
OR = odds ratio; CI = confidence interval

Table 4. Adjusted death among subarachnoid hemorrhage patients with clinically significant arrhythmia

	No arrhythmia		Arrhythmia		Adjusted or (95% CI)	Adjusted *p*
	N	%	N	%		
Death	7	11.5	17	27.9	3.524(1.229 - 10.100)	0.019*
Poor outcome	8	13.1	18	29.5	3.202(1.174 - 8.732)	0.023*

*$P < 0.05$
Adjusted: age, hunt-hess grade, symptomatic vasospasm, poor outcome : gos score ≦ 2

were made, clinically significant arrhythmias were independently predictive of death and poor outcome (Table 4).

DISCUSSION

Many previous studies have shown that electrocardiographic (ECG) changes occur patients with subarachnoid hemorrhage (SAH). However, the precise cause of ECG changes were unknown. Chatterjee et al, suspected that these changes were associated with hypothalamic stimulation and autonomic dysregulations.[3)14)] Pathologically, the myocardium of SAH patients was damaged by a large amount of secreted catecholamines, leading to subendocardial band necrosis.[15)]

Frontera et al, reported that the most common type of clinically significant arrhythmia was atrial fibrillation or flutter (76%) and only 16% of patients in that study experienced ventricular arrhythmia.[10)] In a study by Rudehill et al, the ECG change after SAH varied among the 406 patients; they observed U waves amplitude > 1 mm (47%), T-wave abnormalities (32%), and a prolonged QTc interval (23%).[16)] Other studies have described arrhythmia rates of ≥30% after SAH.[10)] Andreoli et al, reported that cardiac arrhythmias were detected in 64 of 70 patients (91%), and serious cardiac arrhythmias occurred in 29 (41%) patients.[1)] In the present study, 50% (n = 61) of the patients had a verified clinically significant arrhythmia. These wide variations in the prevalence of ECG changes may be attributed to difference in several factors, such as the study design, method of evaluation, and definition of arrhythmia. Routine ECGs were not always performed in cases of inPatient undergoing neurological examination. Thus, a selection bias may be present, which may lead to greater possibility of inclusion of subjects who showed ECG changes after their hospitalization. In many cases, baseline ECGs were not available. Therefore, distinguishing de novo events due to SAH from preexisting ECG changes was very difficult.[3)]

Lacy et al, reported that interruption of the cardiovascular connections between the forebrain and the brainstem within the CNS could lead to identification of the role played by these regions in the development of different types of arrhythmias.[13)] But a previous study reported that the location of intracranial blood was not related to cardiac rhythm disorders.[1)] In our study, there was no statistical significant difference in aneurysm location no arrhythmia group and arrhythmia group as previous study.

Frontera et al. determined that arrhythmia was associated with longer ICU stay that had a profound fiscal implication.[10)] But in the present study, there was no statistically significant difference in ICU stay duration between No arrhythmia group and Arrhythmia group. The determinants of ICU stay varied widely and included systemic complications and mental status.

Many researchers reported that ECG changes after SAH lead to an unfavorable outcome. Frontera et al. reported that Sixteen of 25 (64%) patients who experienced an arrhythmia were dead at 3 months and 1 was severely disabled. The median ICU LOS in those with arrhythmia was 13 days, compared to 8 days in the patients without arrhythmia ($p = 0.002$).[10)] In the present study, although adjustments for the effects of age, Hunt-Hess grade, and the presence of symptomatic vasospasm on death were made, clinically significant arrhythmias were still independently predictive of death and poor outcome.

Arrhythmias are thought to be responsible for clinical deterioration or in some circumstance, acute mortality. It was remarked that the death rate for SAH patients before arriving at a hospital is approximately 15%,[8)] and the aggressive diagnostic and therapeutic maneuvers performed in the acute phase of SAH, particularly when an early surgery protocol is planned (early angiographic study and intracranial surgery, intraoperative hypotension, high-dose mannitol and induced hypervolemia.), may not allow an adequate evaluation of the cardiac condition or, may

themselves be detrimental.[1] Thus, an early cardiological assessment, including continuous ECG monitoring, may be beneficial to SAH patients irrespective of the protocol that is instituted to diagnose the cardiac rhythm disorders early (early or delayed surgery). In a prospective study, Andreoli et al, confirms the early appearance of arrhythmias in a vast majority (91%) of patients with SAH from different sources. Serious rhythm abnormalities affected 41% of cases and were more frequently detected during the first 24 hours of SAH.[1] It is speculated that severe arrhythmias are responsible for the death of some patients, either before a definitive diagnosis of SAH is made or early after admission to the neurosurgical unit.

CONCLUSION

Clinically significant arrhythmias after SAH are associated with a high mortality rate, and serious cardiac and neurological comorbidity. Patients with an clinically significant arrhythmia upon admission should undergo close cardiac monitoring, and the presence of rhythm disturbances should prompt the use of aggressive measures for the treatment of MI, maintenance of normal cardiac rhythm, and minimize the presence of autonomic stress.

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