

Relation between Changing ECG and Location of Aneurysm in Subarachnoid Hemorrhage

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Article Information

Received: 24 Jan 16

Accepted: 09 Mar 2016

Plagiarism software: Turnitin

Keywords:

Cerebral aneurysms,
Subarachnoid hemorrhage,
ECG



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ABSTRACT

Introduction: ECG changes are presented in about 90% of patients with cerebral aneurysm that results subarachnoid hemorrhage (SAH). The most common site of these lesions among the cerebral arteries is anterior cerebral artery which supplies Autonomic cardiovascular centers. However it seems that the location of aneurysm influences critically on changes of ECG, which has not been studied grossly in literatures and there is no definite data to mention that.

Materials and Methods: Here, a cross sectional, retrospective study was done on 500 patients presenting SAH due to cerebral aneurysm which patient's angiography detected the location of pathology. ECG of these patients was taken two times, one on admission and other on discharge after 3rd week of admission.

Results: The mean age of patients was 57.3 years old and this group included 271 male and 229 females. 388 cases had ECG changes; some of them had more than one changed factor. QRS changes were seen in 18 cases on the day of admission, QTc changes were observed in 258 cases, and changes of ST distance were observed in 126 cases. Among all of them, the location of the aneurysm was in Anterior cerebral artery in 142 cases, in communicating arteries in 84 cases, in Middle cerebral artery 64 in cases, in ICA in 36 cases and in Posterior cerebral artery in 52 cases.

Conclusion: In cases which their brain angiography showed cerebral aneurysm, the frequency of ECG changes was more seen. Patients with the anterior cerebral artery aneurysms had more ECG changes. According to the obtained results, ECG of patients with SAH could be a recognized as a factor to understand better the situation of brain after SAH and be useful for managing and treating patients with SAH.

INTRODUCTION

Subarachnoid hemorrhage (SAH) includes only 3% of the stroke cases¹ while is responsible for 50% of deaths due to stroke.² Some reports show 12% of patients with subarachnoid hemorrhage die before admission at hospital and Life expectancy of these patients for next year is between 45 to 57%.³ Among the survived cases, almost half of them suffer neurologic deficits such as repeatedly vessel rupture, symptomatic vasospasm and Hydrocephalus, because of initial bleeding and subsequent complications. The frequency of presenting

SAH in different countries is between 6 to 26 cases among 100000 people. Nowadays, CT scanning and MRI are recognized as first steps to confirmation of SAH and determination of cause of illness.^{4,5}

Cerebral aneurysms which are known as the most cause of SAH, usually happens around the circle of Willis and its branches.^{3,4} The location of aneurysms is critical and important for treatment and prognosis. It has been indicated that blood pressure, smoking and alcohol are crucial factors to make aneurysms or its bleeding.^{6,7}

Several studies have shown that 10 to 15% of patients with cerebral aneurysms die before admission at hospital. As well, the mortality is almost 10% in initial days of these disorders. In initial 30 days of cerebral aneurysms, the mortality rate is 50 to 60%. The survived cases suffer some major disabilities. Also 66% of patients

Access this article online	
Website:	Quick Response code
DOI: 10.5530/ami.2016.2.11	

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who were treated successfully, can't be as same as before SAH.^{8,9}

Normal brain vessels contain a Tunica intima layer including endothelial cell layer covering basal membrane. Myointimal cells separate endothelial cells layer from internal elastic membrane while contain holes, especially in Bifurcations.¹⁰ Patho-physiology of subarachnoid and aneurysm bleeding is defined in tonica media includes soft muscular cells, collagen and extracellular elastic matrix. Recently, it is suggested that hemodynamic factors cause degenerative changes on the vessel walls such as Atherosclerosis or breaking elastic membrane, resulting aneurysm.¹¹

There are different mechanisms showing how brain can change the normal muscle activities of heart. Recent advantages in neurophysiology of cardiovascular control and mechanism of making aneurysm, has been shown the importance of central nervous system to make heart activity disruption. The locations of brain controlling heart activity are diencephalon of brain especially hypothalamus, amygdaloid, cortical zones including sigmoid cortex, frontal lobe, insular cortex and Cingulate gyrus while receiving blood from Anterior cerebral artery. The stimulation of these locations can make changes Q and T waves, ST part and QRS complex, resulting arrhythmia.^{12,13}

Here, we have analyzed particularly the ECG of SAH patients, its variability and type of changes. Also, we have shown, according to the patient's angiographies, a relation between the location and statement of aneurysm and the ECG observed changes.

METHODS

In this study, 500 cases suffering cerebral aneurysm were selected at the Neurology department of Alzahra Hospital in Esfahan, Iran. The mentioned hospital was selected because of easy access to samples and also its facilities.

A cross sectional study was done on the records of all admitted patients suffering cerebral aneurysm between years 2012 to 2014 at Neurology and Neurosurgery departments of Alzahra hospital. At first step, angiographies and ECG of the selected cases before surgery was studied carefully. Factors such as CT reports of patients with SAH and also angiographies clarifying involved artery were paid attention. Then, factors such as heart attack records or CHF and consuming heart medicine were studied. The most important ECG changes such as QT, T wave, ST part, QTc distance (the normalized length of QT is called QTc which is calculated as the length of the current QT divided

by the square root of the distance between two average neighbouring R waves of a particular ECG) and arrhythmia types were paid attention.

A table was written including a variety of factors such as age, gender, initial symptoms, aneurysm location, aneurysm size, existence of disease record, type of treatment, complications before surgery, complications after surgery, time between attack and surgery, existence of reproducible bleeding and outcome. The needed information was taken from the patients records. The obtained data was analyzed using SPSS version 20. Central statistical indicators (mean) and dispersion (standard deviation) were used to determine frequency. T-student test and Chi square correlation test were applied to verify relation between the quantitative variables and qualitative variables, respectively. From the ethical view, no more cost was paid by patients, all patients' information was secret and ethical principles mentioned in the Helsinki agreement were respected.

RESULTS

In this study, 500 cases suffering cerebral aneurysm randomly were selected. The mean age of patients was 57 years old with standard deviation 13, 5. Among the selected cases, 271 of them were male (54, 2%) and 229 females (45.8%). Of 500 patients, 404 cases (80.8%) survived and 96 cases (19.2%) died. The most complications observed among the selected patients were neurologic and then pulmonary problems (Table 1 and Figure 1).

The frequencies of aneurysms were classified in three groups, cases with aneurysms with less than 1 millimeter, 1 to 4 millimeter and more than 4 millimeter (Table 2) (Figure 2). Also, the initial symptoms of patients during admission process were classified (Table 3, Figure 3). Among all patients, 170 cases (34%) had arterial hypertension,

Table 1: Frequency of complications following SAH

Observed complications	Frequency of complications	Percentage in total
Rebleeding	54	10.8
Cardiac	42	8.4
Pulmonary	106	21.2
Hepatic	62	12.4
Neurologic	236	47.2
Total	500	100

Table 2: Frequency of the size of aneurysms

Size of aneurysm	Frequency among patients	Percentage in total
<1 millimeter	106	21.2
1 to 4 millimeter	250	50
>4 millimeter	144	28.8
Total	500	100

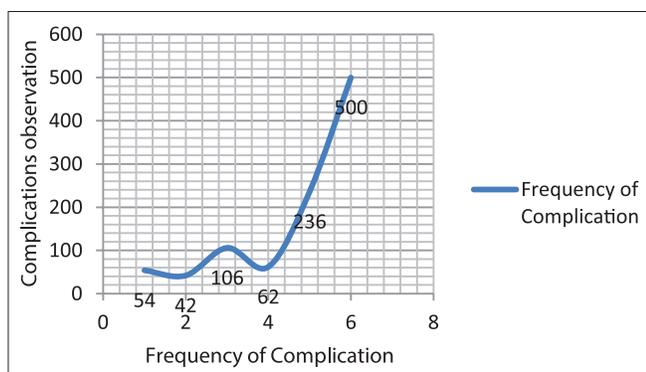


Figure 1: Frequency of complications following SAH

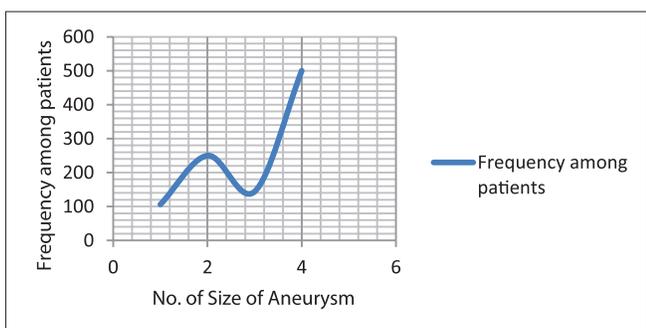


Figure 2: Frequency of the size of aneurysms

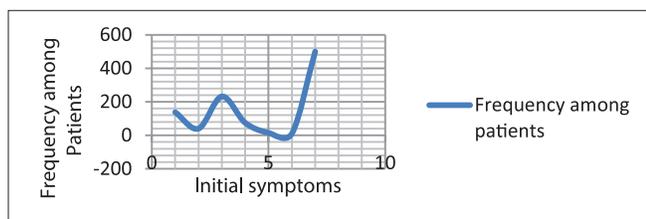


Figure 3: Frequency of initial symptoms on admission

Table 3: Frequency of initial symptoms on admission

Initial symptoms	Frequency among patients	Percentage in total
Headache	138	27.6
Vomiting	40	8
Headache and vomiting	232	46.4
Neck stiffness	75	15
Seizure	15	3
Confusion	10	2
Total	500	100

123 cases (24.6%) diabetes mellitus, 65 cases (13%) smoking custom and 31 cases (6.2%) alcohol drinking custom.

Also, patients were classified to six groups based on their own ages, first group 20 to 30, second one 30 to 40, third one 40 to 50, fourth one 50 to 60, fifth one 60 to 70 and sixth one more than 70 years old. According to this classification, the frequency of complications observed were 7.2% for first group, 13.2% for second group, 23.2% for third group,

27.2% for fourth group, 18.8% for fifth group and 10.4% for sixth group.

According to the obtained results, 79 cases (55.6%) of 142 cases with aneurysm at anterior cerebral artery, 47 (47.9%) cases of 98 cases with aneurysm at communicating artery, 38 cases (43.2%) of 88 cases with aneurysm at internal carotid and 19 cases (21.1%) of 90 cases with aneurysm at posterior cerebral artery had complications.

In addition, 388 cases had ECG changes which some of them had more than one changed factors. 132 cases of the patients with ECG changes (26.4%) had aneurysm in anterior cerebral artery, 84 cases (16.8%) in communicating artery, 64 cases (12.8%) in middle cerebral artery, 56 cases (11.2%) in internal carotid and 52 cases (10.4%) in posterior cerebral artery.

Interestingly, QRS changes were seen among 18 cases on the day of admission, 14 of them with aneurysms in anterior cerebral artery and 4 cases with aneurysms in communicating artery, while only 2 cases with aneurysms in anterior cerebral artery had QRS changes on the day of discharge ($P < 0.0001$). Also, Q-Tc changes were observed in 258 cases on the day of admission, 94 cases with aneurysms in anterior cerebral artery, 60 cases in communicating artery, 54 cases in middle cerebral artery, 28 cases in internal carotid and 22 cases in posterior cerebral artery. On the day of discharge, Q-Tc changes were seen only in 72 cases of 258, while 48 cases with aneurysms in anterior cerebral artery, 10 cases in communicating artery, 6 cases in middle cerebral artery, 6 cases in posterior cerebral artery and 2 cases in internal carotid ($P < 0.0001$). As well, the changes of ST distance were observed in 126 cases, 34 cases in anterior cerebral artery, 20 cases in middle cerebral artery, 10 cases posterior cerebral artery, 8 cases in communicating artery and 30 cases in internal carotid, while was reduced to 12 cases, 10 cases in anterior cerebral artery and 2 cases in posterior cerebral artery ($P < 0.0001$). The obtained result clearly showed a relation between the ECG changes and also the type of its changes with location of Aneurysm in subarachnoid hemorrhage (Table 4:a,b,c and Figures 4,5).

DISCUSSION

Aneurysm is one of the most important complications of cerebrovascular disorders resulting spontaneous bleeding in subarachnoid space and contains 5% of the cerebrovascular accidents.¹⁴ annually, subarachnoid hemorrhage occurs in 10 cases from 100000 persons¹⁵ and usually 45% of cases die and 65% of survived cases suffer complications. As reported, this disorder occurs due to saccular aneurysm rupture.¹⁶ It has been shown that 1 case of 3 patients with aneurysm suffers some disabilities after treatment.² Also, as reported,

Table 4a: frequency of Q-TC changes depending on the place of aneurysm

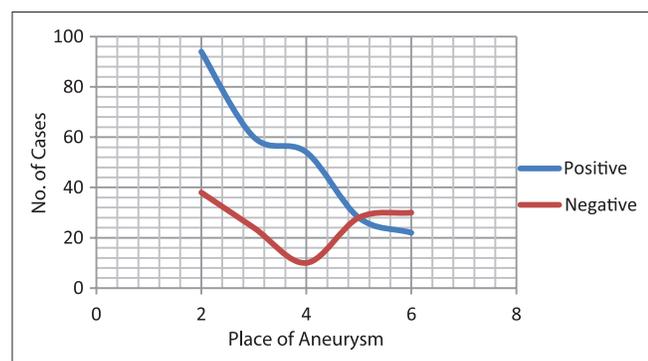
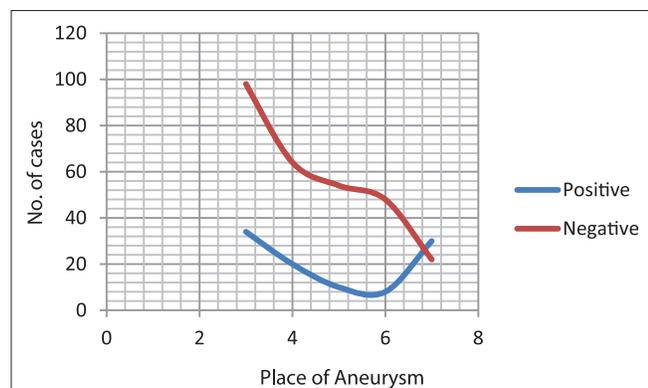
Q-TC change place of aneurysm	Positive	Negative
Anterior cerebral artery	94	38
Communicating artery	60	24
Middle cerebral artery	54	10
Internal carotid artery	28	28
Posterior cerebral artery	22	30

Table 4b: Frequency of ST changes depending on the place of aneurysm

ST change place of aneurysm	Positive	Negative
Anterior cerebral artery	34	98
Communicating artery	20	64
Middle cerebral artery	10	54
Internal carotid artery	8	48
Posterior cerebral artery	30	22

Table 4c: Frequency of QRS changes depending on the place of aneurysm

QRS change place of aneurysm	Positive	Negative
Anterior cerebral artery	14	118
Communicating artery	4	80

**Figure 4:** Frequency of Q-TC changes depending on the place of aneurysm**Figure 5:** Frequency of ST changes depending on the place of aneurysm

the cause of the most of cases dying due to aneurysm is the complications of repeatedly bleeding usually on the firstly third weeks of aneurysm.^{1,3}

In this study, we were interested to know whether aneurysm and also the location of aneurysm influences on changes of ECG or not. To do this investigation, a cross sectional study was done on 500 patients presenting SAH due to cerebral aneurysm which patient's angiographies detected the location of pathology. ECG of these patients was taken two times, one on admission and other on discharge after 3rd week of admission.

The mean age of cases was 57.3 years old and the most cases were between 40 to 60 years old. Compared to the other studies performed 10 years ago, it is clear that the mean age of patients has decreased (in other studies the most cases had 55 to 65 years old). This observation means that during last 10 years, probably demographic and stressful situations cause increasing blood pressure among people. Also differentially cultural public view about blood pressure and the time that patients refer to the health system are other effective parameters influencing on reducing the age of patients.¹⁷⁻²¹

In our study, 45.8% of cases with aneurysm admitted at Alzahra hospital in the centre of Iran were women (during 2012 to 2014), showing the frequency of this disease is more common among male. The same results were observed in another study in the west of Iran showing men is more in danger of this disease compared to women.¹⁹ However, some reports from Europe show that the frequency of aneurysm is much more common among women than men (58% of cases were women).^{15,16} This observation probably comes back to this event that the behaviors increasing the risk factors of aneurysm such as smoking, blood pressure and stress are higher among male compared female in Iran.²²

Generally, ECG changes are very common during subarachnoid bleeding. As reported, almost 90% of cases with the subarachnoid bleeding show ECG changes. The most common cause of SAH is cerebral artery aneurysm rupture occurring most at anterior cerebral artery, as report with 40% of frequency among the aneurysms.²³

First time, ECG changes due to acute brain attack was reported in 1974, while 2 cases of 4 patients with brain attack suffering acute myocardial infarction had SAH.²³ Later, a study was performed on 19 cases with SAH while 13 of them had at least one of the heart risk factors. During this study, thallium scanning of the cases was done to see their myocardial changes. The obtained results showed that only 32% of cases with ECG problems had positive thallium scanning, displaying that 68% of ECG changes came from SAH.²⁴ Another study has shown that changes during the time of repolarization in ECG (is called T-wave brain) can be reversed by aneurysm surgery. It has been suggested that the origin of T-wave brain comes from hypothalamus.²⁵ T-wave brain also was observed at our study, suggesting

that it could be recognized as a useful prognostic factor to determine existence or non-existence of cerebral aneurysm in patients with SAH.

In our study, we have observed that there is a strong relation between ECG changes with the location of aneurysms, for example the QRS changes of ECG are more common among patients with aneurysms in anterior cerebral artery; Q-Tc changes were more common among patients with aneurysm in communicating artery and middle cerebral artery and ST changes of ECG is more common among patients with internal carotid artery aneurysms.

In addition, we have shown that a dominant relation between changing ECG and location of aneurysm in subarachnoid hemorrhage exists and paying attention to ECG of non-traumatic SAH patients could have indirect role on managing these patients.

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How to cite this article: Najarzadegan MR, Shahabi J, Shalbafan MR, Rahimpour M, Ataei E. Relation between changing ECG and location of aneurysm in subarachnoid hemorrhage. *Acta Medica International*. 2016;3(2):46-50.

Source of Support: Nil, **Conflict of Interest:** None declared.