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Risk Factors of Early Neurologic Complications after CABG Surgery

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Abstract

***Background*:** Coronary Artery Bypass Graft surgery (CABG) is one of the most common surgery procedures performed annually in worldwide. The objective of this study is to determine the prevalence and risk factors of the early neurologic complications emerged after CABG surgery.

***Materials and Methods*:** In a cross-sectional study we have investigated 160 consecutive patients undergoing CABG between July 2008 and April 2011 in cardiac surgery ward. Risk factors that evaluated in our analysis consist of hypertension (HTN), diabetes, age, sex, perioperative Myocardial Infarction (MI), postoperative atrial fibrillation, duration of aortic clamp, severity of carotid artery stenosis and addiction. Our dependent variables were delirium, CVA and seizure. The data were analyzed by SPSS-16 with Chi-square test and $p<0.05$.

***Results*:** In our analysis, of total 160 patients, 58 (36.2%) were female. Mean age of patients was 62.7±9.6 years. Of total patients, 71 (44.4%) were found to have HTN, 35.6% had diabetes, 18.8% had atrial fibrillation, 30.6% had a history of preoperative MI and 10.6% had addiction. Mean time of aorta clamp time was 78.5±8.9 min. The incidence rate of delirium after CABG was 12 out of 160 patients (7.5%) and for CVA were 2 (1.2%). There was not any seizure among our population. Of total patients, 7% of diabetic patients, 8.5% of patients with HTN, 16.7% with atrial fibrillation and 8.2% of patients with a history of preoperative MI affected with delirium after the CABG surgery. In our analysis, no significant correlation observed between delirium and these risk factors. In present study, duration of aortic clamp had a significant relation with CVA after CABG ($p=0.0001$).

***Conclusion*:** According to this analysis, duration of aorta clamp time is one of the most important risk factors of CVA after CABG.

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Introduction

Coronary Artery Bypass Graft (CABG) surgery is one of the most prevalent surgeries performed annually throughout the world. More than 500000 CABG surgeries are performed in the U.S. annually [1]. In Iran, more than 38% of mortalities are caused by cardiovascular diseases, especially coronary artery diseases which require surgery in most of the cases [2]. Those individuals undergoing these surgeries are mostly of the elderly people suffering from coronary artery disease and are undergone the surgery either as an emergency surgery or an elective surgery. This surgery is performed in two forms, i.e. On-Pump and Off-Pump, most of which performed in Iran are of On-Pump CABG type in which the patient is subject to Cardio Pulmonary Bypass (CPB) and the necessary actions are performed. This surgery comes with some complications as is the case for other surgeries which the neurologic and cognitive complications constitute an important portion of these complications. The neurologic complications like the stroke and the cognitive complications like the delirium are regarded as the most prevalent and important complications occurred after CABG which can also affect the patient' quality of life at next year's and increase the patient's hospital stay [3, 4].

Based on the performed studies, the incidence rate of stroke after CABG surgery is in the range 0.8-5.2%. The stroke's incidence rate was reported equal to 1.4% in a previous study [5]. Moreover, the incidence time of stroke after CABG surgery varies considerably. Those patients who are affected with stroke after the surgery have poor prognoses compared to those without this complication. However, etiology of stroke after CABG varies and some factors such as the high age, atherosclerosis disease and stroke background are regarded as the stroke's risk factors after CABG [6]. In a previously performed study, the death risk of patients affected with stroke was three times higher than those without stroke [7]. Delirium is defined as the disorders of consciousness and care together with cognitive changes and disturbed perception and has abrupt start time and variable phases. The prevalent symptoms of delirium include the memory disorders, lack of time and place perception, irrelevant words, illusion and delusional

disorder [8- 10]. Delirium may not be recognized in 84-86% of patients because of its acute start, variable phases and clinical protests which are similar to depression and dementia [11, 12].

Delirium occurs in 3-32% of patients after CABG surgery, especially in patients with the history of cerebral problems, considerable use of alcohol, high age, or intracranial vascular problems [13-15]. In the results obtained from the investigations it was revealed that delirium causes increased mortality and morbidity rates after the surgery up to 20-30% [16]. About 0.5-3.5% of the patients are affected with seizure after the CABG surgery. Among the causes of the seizure one can mention the hypoxemia, metabolic disorders, drug toxicity and the brain's structural damages like the stroke [13, 15]. It was demonstrated in a study that for each decade of age increase, the risks of early and delayed complications are increased by 1.75% and 2.20%, respectively. The background of nervous diseases also increases the chance of occurrence for early complications. Reducing the duration of aorta clamp time causes a reduction in prevalence of neurologic complications [18, 17, 13].

The prevalence of delirium has been reported to be 41.7% and the prevalent preoperative risk factors reported for the patients affected with delirium include high age, celibacy, a history of neurologic diseases, diabetes mellitus, atrial fibrillation, kidney disease and LVEF 30; and the postoperative risk factors include atrial fibrillation, dehydration, hypoalbuminemia, liver disorders, blood loss more than one liter, cardiogenic shock, acute infection and the hematocrit below the 30% [19, 20]. Generally speaking, based on the previously performed studies, the history of previous cerebral accidents, diabetes mellitus, hypertension, Pheripheral Vascular Diseases (PVD) are in turn the risk factors for incidence of neurologic complications after the heart surgery.

Moreover, the existence of atherosclerosis in carotid arteries and ascending aorta can increase the probability of thromboembolism. The recognition of these factors and controlling them can greatly reduce the incidence rate of the complications [21, 22]. Regarding this fact that numerous factors have been reported as the risk factors and postoperative complications in different studies and no study has been ever conducted so far in this regard in Qazvin, the present study was designed aiming to determine the prevalence and risk factors of local and early neurologic complications in the patients after CABG surgery in Ibn-e-Sina hospital of Qazvin in order to evaluate the risk factors and complications of the above-mentioned surgery.

Materials and Methods

This research was a cross-sectional study conducted in Ibn-e-Sina hospital of Qazvin. In this study, 160 consecutive patients undergoing CABG between July 2008 and April 2011 in cardiac surgery ward of Ibn-e-Sina hospital were investigated. A checklist was prepared including the variables studied for evaluation of each patient. Risk factors that were evaluated in our analysis consist of: hypertension background, diabetes mellitus, age, sex, perioperative MI, postoperative atrial fibrillation, duration of aorta clamp time, severity of carotid artery stenosis and addiction. Our dependent variables were delirium, Cerebro-vascular accident (CVA) and seizure.

The variables include hypertension (the increase of the systolic blood pressure up to much than 140 and the diastolic blood pressure up to much than 90), diabetes mellitus (the increase of fasting blood sugar or FBS) up to much than 126 mg/dl and less than 200 mg/dl two hours after eating), atrial fibrillation (atrial arrhythmias with the fibrillation pattern as the irregular waves without P waves in ECG) after the surgery, a history of myocardial infarction (permanent ischemic myocardial lesions) as a result of reduced myocard perfusion together with the raise of ST and Q waves) before the surgery, age, sex, duration of aorta clamp time (the close time of heart-lung aorta pump in minutes), existence of atherosclerosis disease in carotid arteries (artery stenosis reported as percent diameter stenosis of the carotid artery), a history of drug addiction, delirium incidence (including disorders in the patient's level of consciousness and cognitive function as a series of disorders ranged from agitation to widespread apathy) after the surgery, incidence of seizure after the surgery and incidence of local complications like the CVA. The postoperative CVA and seizure were evaluated by the neurologist and using the examination of patients and evaluation of MRI and CT scan tests results.

In this study, all the patients undergoing the CABG surgery in the above-mentioned date in Ibn-e-Sina hospital were evaluated. The resources employed in this plan were patient records. Each record includes the complete history and special forms with the patient status recorded carefully in these records. For this plan, the patients' status records were evaluated for history of hypertension, diabetes mellitus, MI and addiction. Moreover, for the high-risk and above 65-years-old patients, the history of diabetes mellitus in each age, the history of CVA and or the Transient Ischemic Attack (TIA) in each age and the history of left main lesions were evaluated. The color Doppler ultrasound of carotid arteries was performed for the evaluation of atherosclerosis in carotid artery (the indications used for evaluation were as follows: age>65, the history of diabetes mellitus in each 30 previous MI, in each 30 previous TIA, in each 30 previous main left lesions).

In this study, the patients affected postoperatively with apathy or reduced level of consciousness and or palsy, were investigated using the special neurology tests by the neurologist in order to specify the accuracy of the nerve lesion and its type.

The data recording was in an anonymous manner and the participation in the study was voluntary and optional. Moreover, the above-mentioned plan was matched with the format approved by the Ethics Committee of the Qazvin University of Medical Sciences. The statistical analysis was done using the Chi-squared test with the *p*-Value less than 0.05. This analysis was performed using the SPSS-16 software.

Results

In this study, 160 patients undergoing CABG between July 2008 and April 2011 in Ibn-e-Sina hospital were investigated. Of total 160 patients, 58 (36.2%) and 102 (63.8%) were female and male respectively. Mean age of the patients was 62.7±9.6 years. Most of the examined patients were in the age range 38-84. After the CABG surgery, of total 160 studied patients, 12 (7.5%) and 2 (1.2%) people were affected with delirium and CVA, respectively and no seizure incidence was observed. In the performed examination, of total 160 patients, 71 (44.4%) had HTN, 57 (35.6%) had the history of diabetes mellitus, 30 (18.8%) had post-operative atrial fibrillation, 49 (30.6%) had history of pre-operative MI and 17 (10.6%) had addiction. The mean time of aorta clamp time in all patients was 78.5±8.9 min (Table 1). 47 out of total patients were examined using color Doppler-ultrasound. Of total of 57 diabetic patients, 4 (7%) were affected with postoperative delirium.

Of total of 71 patients with HTN, 6 people (8.5%) have been affected with delirium, i.e. 50% of patients suffering from delirium had the history of HTN. Of total of 49 patients with preoperative MI, 4 people (8.2%) were affected with delirium and 33.3% of patients with delirium had the history of MI. Of total of 30 patients with postoperative atrial fibrillation, 5 people (16.7%) were affected with delirium and 41.66% of patients affected with delirium had a history of preoperative atrial fibrillation. The mean age for the people affected with delirium was 62.3±11.1 (Table 1).

A total of 57 individuals suffering from controlled diabetes mellitus, one person (1.8%) were affected with CVA postoperatively. Namely, 50% of patients affected with CVA had a history of diabetes mellitus. Of total individuals having HTN background, no case was affected with CVA postoperatively. Of total individuals having preoperative MI background, no case was affected with CVA postoperatively. Of total individuals who had a history of postoperative atrial fibrillation (30 people), only one person (3.3%) was affected with CVA after CABG surgery. In other words, 50% of people affected with CVA had a history of postoperative atrial fibrillation.

In classification of age into 5 age groups, all the postoperative CVA accidents (2 patients) had been occurred in the age range 65-74 and of total 61 patients in this age group, 3.3% were affected with CVA. Of total population of women and men, one woman (1.8% of women) and one man (0.98% of men) had been affected with CVA after the CABG surgery.

Table 1. Comparison of the mean age and the duration of aorta clamp time in terms of existence or lack of delirium and CVA

	CVA			Delirium		
	Not affected	affected	*p*-value	Not affected	affected	*p*-Value
Mean age (years old)	62.6±9.7	69±11.4	0.5	62.8±9.5	62.3±11.1	0.5
Mean duration of aortic clamp (minute)	78.04±16.1	120.5±84.1	0.0001	78.1±18	83.7±16.7	0.8

Table 2. Comparison of the prevalence of delirium and CVA complications in terms of risk factors

Risk factors		CVA (%)		*p*-Value	Delirium (%)		*p*-Value
		Lacks	Has		Lacks	Has	
Sex	Female	35	0.6	0.5	32.5	3.1	0.4
	Male	63.8	0.6		60	4.4	
Age range (year)	35-44	3.8	0	0.5	3.8	0	0.5
	45-54	16.2	0		13.8	2.5	
	55-64	31.9	0		30	1.9	
	65-74	36.9	1.2		35.6	2.5	
	75-84	10	0		9.4	0.6	
Severity of aortic stenosis (%)	>50	0	0	-	0	0	-
	<50	98.7	1.3		92.5	7.5	
Duration of aortic clamp (min.)	30-60	10	0	0.0001	9.4	0.6	0.8
	60-90	69.4	0.6		65	5	
	90-120	17.5	0		15.6	1.9	
	>120	1.9	0.6		2.5	0	
Addiction background	yes	10.6	0	0.7	10.6	0	0.2
	no	88.1	1.2		81.9	7.5	
MI background	yes	0.6	0	0.4	28.1	2.5	0.5
	no	68.1	1.2		64.4	5	
Fibrillation	yes	18.1	0.6	0.3	15.6	3.1	0.05
	no	80.6	0.6		76.9	4.4	
Diabetes background	yes	35	0.6	0.5	33.1	2.5	0.5
	no	63.8	0.6		59.4	5	
Seizure	yes	0	0	-	0	0	-
	no	98.8	1.2		92.5	7.5	
Blood pressure	yes	44.4	0	0.4	40.6	3.8	0.3
	no	54.4	1.2		51.9	3.8	

With regard to the relationship between the CVA and the duration of aorta clamp time, one case of CVA was occurred in group 60-90 min; and one other case was occurred in group >120 min. (p=0.0001). Of total people affected with delirium, 5 people (41.6%) were female and 7 people (58.3%) were male. No significant correlation was observed between the frequency of delirium and the duration of aorta clamp time (Table 2). None of the individuals under the study had a severity of aortic stenosis more than 50%.

Of total 12 cases of delirium, no case was observed with a history of addiction and drug use. Moreover, none of the patients were affected with CVA postoperatively. None of the addict patients were affected with CVA postoperatively. Of total individuals under the study, no case of seizure was observed.

Discussion

The CABG surgery is one of the most prevalent surgeries throughout the world that many patients are undergone this surgery annually. The neurologic complication after the CABG surgery is one of the most prevalent and most costly postoperative complications. In this study, 44.4% of patients had HTN, 35.6% had a history of diabetes mellitus, 18.8% had postoperative atrial fibrillation, 30.6% had preoperative MI and 10.6% had addiction. The mean duration of aorta close time in all the patients was 78.57±8.9. The incidence rates of postoperative delirium and CVA were 7.5% and 1.2%, respectively. No case of seizure was observed in this study. Of total studied patients, the following percentages of patients were affected with postoperative delirium: (7%) of diabetic patients, 8.5% of patients with HTN, 8.2% of patients with preoperative MI and 16.7% of patients with postoperative atrial fibrillation. No significant correlation was observed between these risk factors and the incidence rate of delirium. In this study, the duration of aorta close time had a significant correlation with the incidence rate of CVA and no clear correlation was observed between the other risk factors and the CVA incidence rate.

In our study, no significant correlation was observed between the age and neurologic complications that is contrary to the results of previous studies [23, 24]. Moreover, in the present study, no significant correlation was found between the patient's sex and the incidence rate of neurologic complications that is contrary to the results of other studies. It was demonstrated in different studies that the neurologic complications and the mortality rate in women are significantly higher than those in men [25-27]. In this study, we didn't find any significant correlation between the diabetes mellitus and the incidence rate of neurologic complications. This may be caused by the small number of the studied samples and the control implemented on the diabetic patients during surgery and on the other hand, this subject can be indicative of this issue that the diabetes mellitus isn't itself a risk factor of complications alone. With regard to the relationships with the HTN, it can be said that strong and clear relationship was observed between the history of HTN and the prevalence of postoperative neurologic complications. It was demonstrated in different studies that the HTN plays a key and pivotal role in the prevalence of these complications [28- 30], but some studies did not validate this relationship or reported a poor relationship [31, 6]. In this study, no significant correlation was observed between the HTN and the prevalence of these complications. This result can be indicative of this fact that the existence or lack of blood pressure control cannot cause the complications alone. On the other hand, the small number of the examined samples under this study can disturb the conclusion process. Among other risk factors under the study one can mention the preoperative MI. In most of the studies ever conducted, the MI is regarded as one of the most important risk factors of neurologic-cognitive complications after the CABG [23, 6]. In contrary to the above results, Loponen demonstrated in Finland that MI plays itself no important role in prevalence of these complications alone [3].

In this study, we could not reach any significant correlation between the preoperative MI and the neurologic complications after the CABG surgery. This result can be a proof of this fact that the MI has not itself lead to neurologic complications alone and other risk factors must be existent as the accompanying factors. Among other risk factors that can contribute to prevalence of neurologic complications after the CABG surgery is the incidence of the cardiac arrhythmias, especially the atrial fibrillation after the surgery. Hogo, in a study conducted in the U.S. concluded that the atrial fibrillation does not contribute to postoperative neurologic complications alone, a result which was contrary to the previous findings [32, 34, 35]. In this study, no significant and reasonable correlation was found between the existence of atrial fibrillation and the incidence of neurologic complications after the CABG. In our study, the number of people who were affected with neurologic complications after the emergence of the atrial fibrillation was almost equal to those who hadn't experienced the postoperative atrial fibrillation, but had been affected with the complications. From these statistics, we can conclude that the atrial fibrillation hadn't caused these complications alone and some other disorders must be existent together with the atrial fibrillation in order to cause its negative effects. The type of surgery, the use of heart-lung pump, the use of anticoagulants and antiplatelet drugs and their prescription after the surgery play a protective role against the CVA in these patients. Of another studied risk factors, one can mention the duration of aorta clamp time during CABG surgery. The examinations have demonstrated that the most of embolisms during the CABG are caused by the aorta clamping. The arteries in these patients are generally affected with atherosclerosis and result in the state on being dug for these platelets during manipulation by the surgeon and cause the Macroembolism which can result in the Ischemia in the brain [17].

In this study, the duration of aorta clamp time had a significant correlation with the incidence rate of the

postoperative CVA which is indicative of this variable's effective and independent role in the incidence of this problem. This result can be attributed to the Ischemia generated after the aorta clamping. In contrary to CVA, the duration of aorta clamp time had no significant correlation with the incidence of seizure and delirium in this study. Another risk factor which is studied in this study is the severity of carotid artery stenosis that its diagnosis and measurement was performed preoperatively using the color Doppler ultrasound for the patients who had a history of previous CVA, diabetes mellitus, an age above the 65, a history of transient ischemic attack in any age or a history of main left lesions. Some previously conducted studies have confirmed this correlation and some other studies have denied it [17, 19].

In this study, based on the performed statistical studies, no salient and significant correlation was found between the mild and moderate stenosis of the carotid artery and the incidence rate of the neurologic complications after the CABG surgery. This result can be indicative of this fact that this type of carotid artery stenosis cannot itself alone be a risk factor for the neurologic-cognitive complications after the CABG surgery and it may be hazardous only when accompanied by other risk factors.

Another risk factor studied in this research was the effect of addiction on the incidence rate of neurologic complications after the CABG surgery. Regarding this fact that this risk factor hasn't been studied precisely in the past, so the result obtained from this study cannot be evaluated. In this study, not any correlation was found between the addiction and the incidence rate of the complications. More studies must be performed in this regard in order to be able to verify or deny its effect.

Generally speaking, the results of this study show that among the risk factors set forth for the postoperative incidence of complications, only the duration of aorta clamp time is regarded as one of the most important risk factors of the CVA after the CABG surgery alone and the other risk factors, despite their existence, had no significant correlation with the incidence of complications. Regarding the results of this study, the recognition of the risk factors in the cardiac patients and the attempts to reduce and control these risk factors can lead to better prognosis and conditions for the patients after the CABG surgery. Regarding this fact that the present study has been done in a hospital center, one can perform this study in other centers and examine the results collectively that in this case regarding the increased number of samples studied, the obtained result would have smaller error and enjoy higher degree of confidence.

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Authors' Contributions

All authors had equal role in design, work, statistical analysis and manuscript writing.

Conflict of Interest

No conflict.

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