Original Article

Factors Related to Prolonged Recovery of Consciousness Following Cardiac Surgery

Zahra Faritous[1], MD; Somayeh Madadipoor[1], MS; Behshid Ghadrdoost[1], PhD; Evaz Heidarpour[1], MD; Maryam Moradian[1], MD; Mohsen Ziyaeifard[1]*, MD

ABSTRACT

Background: Recovery from anesthesia may be defined as a state of the patient's consciousness that consists of awareness of surroundings and identity. Prompt recovery of consciousness from anesthesia is essential for the evaluation of central nervous system dysfunction after cardiac surgery. The present study aimed to investigate the factors associated with recovery of consciousness following cardiac surgery.

Method: In this study, 665 patients who underwent cardiac surgery were enrolled. Patient and surgery-related factors were collected through data sheets. Univariate and multivariable logistic regression models were used to identify factors related to prolonged recovery of consciousness.

Results: The mean age of all the patients was 55.74 ± 13.85 years, and most of the patients were male (61.8%). There were significant associations between recovery of consciousness time and age (P = 0.001), neurological diseases (P = 0.001), respiratory diseases (P = 0.001), history of cerebrovascular accident ($P < 0.0001$), and history of arrhythmias (P = 0.01). Among cardiac risk factors, there were significant relationships between diabetes mellitus (P = 0.001), hypertension (P = 0.001), cigarette smoking (P = 0. 01), and opium addiction (P = 0.02) and delayed recovery of consciousness after anesthesia. The multivariate analysis of the factors potentially influencing recovery of consciousness time after cardiac surgery showed that age (OR: 1.04), cigarette smoking (OR: 1.94), diabetes mellitus (OR: 1.71), history of cerebrovascular accident (OR: 2.97), pump time (OR: 1.01), and intubation time (OR: 1.21) had significant relationships with prolonged recovery of consciousness ($P < 0.05$).

Conclusions: This study showed that old age, cigarette smoking, diabetes mellitus, longer pump time, longer intubation time, and history of cerebrovascular accident were risk factors for prolonged recovery of consciousness after cardiac surgery. These findings provide valuable information for effective patient care and anesthetic management after cardiac surgery. ***(Iranian Heart Journal 2017; 18(4):42-47)***

KEYWORDS: Recovery of consciousness, General anesthesia, Cardiac surgery

[1] Rajaie Cardiovascular, Medical, and Research Center, Iran University of Medical Sciences, Tehran, IR Iran.

*** Corresponding Author:** Mohsen Ziyaeifard, MD; Department of Cardiac Anesthesia, Rajaie Cardiovascular, Medical, and Research Center, Iran University of Medical Sciences, Valiye-Asr St, adjacent to Mellat Park, Tehran, IR Iran.
Email: mziyaeifard@yahoo.com **Tel:** 02123922152

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The past 20 years have witnessed a significant rise in the number of patients who undergo cardiac surgery. One of the most important complications after open-heart surgery is central nervous system dysfunction, which affects the postoperative morbidity and mortality rates. [1] Delayed consciousness is known as a serious central nervous system dysfunction after surgery and is defined as regained clear consciousness at least 6 hours after open-heart surgery. [2]

The process of recovery after anesthesia is divided into 3 phases: (1) immediate recovery, which usually takes a short time and consists of the return of consciousness, recovery of protective airway reflexes, and resumption of motor activity; (2) intermediate recovery, which usually lasts for 1 hour after a short anesthesia and consists of regained power of coordination; and (3) long-term recovery, which denotes the full recovery of coordination and higher intellectual function. [2]

Prompt recovery of consciousness from anesthesia following cardiac surgery is essential for the early diagnosis of central nervous system damage. [3] In addition, recovery of consciousness is the most important criterion for tracheal extubation and weaning from mechanical ventilation after cardiac surgery, which can reduce the incidence of delayed extubation, side effects of mechanical ventilation and immobilization, intensive care unit (ICU) length of stay, and hospital costs. [4, 5]

Although previous studies have reported some factors that seem to affect recovery of consciousness from anesthesia such as gender and age, only a few studies have ever investigated factors associated with recovery of consciousness time after open-heart surgery. Accordingly, we conducted the present study to assess which factors—including patient characteristics and surgery-related factors—could exert significant effects on recovery of consciousness time from general anesthesia in patients undergoing cardiac surgery.

METHOD

In the present study, 665 patients who underwent cardiac surgery in Rajaie Cardiovascular, Medical, and Research Center between June 2015 and September 2015 were enrolled. The inclusion criteria included a minimum age of 20 years without previous disturbance of consciousness and receiving the same anesthetic protocol. Patients were excluded if they had neurological deficits that affected recovery, need for postoperative sedation, or need for further surgery in the first 6 hours after the surgical operation.

Anesthesia was induced for all the patients with benzodiazepines (0.05–0.1 mg/kg of midazolam), opioids (25–40 µg/kg of fentanyl or 2.5–4 µg/kg of sufentanil), muscle relaxants (0.5 mg/kg of atracurium or 0.1 mg/kg of pancuronium), and thiopental (1–2 mg/kg) before tracheal intubation. Thereafter, anesthesia was maintained with midazolam, fentanyl or sufentanil, atracurium or pancuronium, and isoflurane up to 1%.

During the anesthesia and surgery, all the patients had routine monitoring—including pulse oximetry, electrocardiography, indwelling arterial catheterization, and central venous catheterization. All the surgical operations were performed with cardiopulmonary bypass (CPB) at mild-to-moderate core hypothermia (28–32°C). Myocardial protection was accomplished with intermittent antegrade or combined antegrade and retrograde saline or blood cardioplegia.

After the surgery, all the patients were transferred to the cardiovascular ICU while they were intubated and given mechanical ventilation support. Consciousness and neurological status were regularly evaluated in the patients using the Glasgow Coma Scale (GCS). The patients who obeyed verbal commands and had GCS scores of 12 or higher were considered conscious. Delayed consciousness was defined as regained clear consciousness at least 6 hours after open-heart surgery.

All the preoperative and intraoperative variables were collected; they included demographic data such as age, gender, race, weight, height, body mass index, left ventricular ejection fraction, blood acid-base status using arterial blood gases; underlying diseases; biochemical tests; and information related to surgical variables such as operating time, CPB time, cross-clamp time, and the type of cardiac surgery.

This study was approved by our local ethics committee and was conducted in accordance with the Helsinki Declaration of the World Medical Association (2000).

Statistical Analysis

Mean values, standard deviations (SDs), and frequencies were used as descriptive analysis. The qualitative data were compared using the χ^2 test. The Student *t*-test or the Mann–Whitney *U* test was employed to compare the quantitative variables. Variables that had any relationship with delayed consciousness were entered into a multivariable logistic regression model using the backward variable-selection method, constructed based on the variables that resulted significant (P <0.05) from the univariable analysis.

RESULTS

The present study was conducted on 665 patients who underwent cardiac surgery. From this total, 124 patients had recovery of consciousness more than 6 hours postoperatively; consequently, the rate of delayed consciousness in our study was approximately 18.64%.

All the baseline characteristic data of the study population are demonstrated in Table 1. The mean age of the patients was 55.74 ± 13.85 years, and most of the patients were male (61.8%).

Table 1. Baseline characteristics of the study population

Variable	Mean± SD, N (%)
Age (y)	55.74±13.85
Sex (male/female)	411/254
BMI	26.14±4.58
Risk factors	
DM	230 (34.6%)
HTN	316 (47.7%)
HLP	264 (39.7%)
cigarette smoking	200(30.1%)
opium addiction	92 (13.8%)
Underlying disease	
thyroid diseases	44(6.6%)
neurological diseases	44(6.6%)
cardiovascular diseases	43 (6.5%)
renal diseases	77 (11.6%)
liver diseases	8 (1.2%)
respiratory diseases	33 (5%)
coagulopathies	264 (39.7%)
mental disorders	3 (0.5%)
History of CVA	19 (9.2%)
History of arrhythmia	54 (6.8%)
History of previous surgery	139 (48%)
History of MI	135 (20.3%)

BMI, Body mass index; DM, Diabetes mellitus; HTN, Hypertension; HLP, Hyperlipidemia; CVA, Cerebrovascular accident; MI, Myocardial infarction

The surgery-related data of all the patients are depicted in Table 2. The most frequent surgery was coronary artery bypass graft (CABG) (totally 65.5%), and the majority of the surgical operations were done electively (90%).

Table 2. Surgery-related data of the study population

Surgery-Related data	N (%)
Type of surgery	
CABG 1 graft	13 (1.95%)
CABG 2 grafts	65 (10%)
CABG 3 grafts	205 (30.8%)
CABG 4 grafts	135 (20.3%)
CABG 5 grafts	18 (2.7%)
Congenital	28 (4.21%)
Valve replacement	159(23.9%)
Valve repair	13(1.95%)
CABG + valvular surgery	29 (4.36%)
On-pump	637(95.8%)
Off-pump	28(4.2%)
Pre-IABP	0(0%)
Post-IABP	18(3.7%)
Emergency surgery	65(9.8%)

CABG, Coronary artery bypass grafting; IABP, Intra-aortic balloon pump

The comparisons of the baseline characteristics and surgery-related data between the group of patients with delayed consciousness and the group of patients with timely consciousness following cardiac surgery are shown in Table 3. There were significant associations between recovery of consciousness time and age (*P* = 0.001), neurological diseases (*P* = 0.001), respiratory diseases (*P* = 0.001), history of cerebrovascular accident (CVA) (*P* < 0.0001), and history of arrhythmias (*P* = 0.01). Among cardiac risk factors, there were significant relationships between diabetes mellitus (*P* = 0.001), hypertension (*P* = 0.001), cigarette smoking (*P*=0.01), and opium addiction (*P*=0.02) and delayed recovery of consciousness.

Table 4 shows the multivariate analysis of the factors potentially influencing recovery of consciousness time after cardiac surgery. In this model, age (OR: 1.04), cigarette smoking (OR: 1.94), diabetes mellitus (OR: 1.71), CVA history (OR: 2.97), and pump time (OR: 1.01) had significant relationships with prolonged recovery of consciousness (*P* < 0.05). The effects of the other significant factors in the univariate analysis vanished after further adjustment for these 6 factors.

Table 3. Association between recovery of consciousness time and patient-related factors

	Delayed Consciousness	Timely Consciousness	*P*
Age (y)	60.88±12.30	54.56±13.92	0.001
Sex female	38 (30.6%)	216 (39.9%)	0.055
male	86 (69.4%)	325 (60.1%)	
Thyroid diseases	5(4%)	39(7.2%)	0.16
Neurological diseases	18(14.5%)	26(4.8%)	0.001
Cardiovascular diseases	11(8.9%)	32(5.9%)	0.22
Renal diseases	15(12.1%)	62(11.5%)	0.84
Liver diseases	1(0.8%)	7(1.3%)	0.65
Respiratory diseases	14(11.3%)	19(3.5%)	0.001
Coagulopathies	208(38.4%)	0(0%)	0.16
Mental disorders	0(0%)	3(0.6%)	0.41
History of CVA	18(14.5%)	27(5%)	<0.0001
History of arrhythmia	17(13.7%)	37(6.8%)	0.01
History of previous surgery	59 (47.6%)	260(48.1%)	0.92
History of MI	29(23.4%)	106(19.6%)	0.34
Risk factors			
DM	59(47.6%)	171(31.6%)	0.001
HTN	82(66.1%)	234(43.3%)	0.001
HLP	208(38.4%)	56(45.2%)	0.16
cigarette smoking	49(39.5%)	151(27.9%)	0.01
opium addiction	25 (20.2%)	67(12.4%)	0.02

DM, Diabetes mellitus; HTN, Hypertension; HLP, Hyperlipidemia; CVA, Cerebrovascular accident; MI, Myocardial infarction

Table 4. Multivariate analysis of the factors influencing recovery of consciousness time after cardiac surgery

Variable	*β*	OR	*P*	%95 CI
Age	0.042	1.04	<0.001	1.02-1.06
Smoking	0.661	1.94	0.006	1.21-3.11
DM	0.53	1.71	0.024	1.07-2.71
CVA	1.09	2.97	0.005	1.39-6.37
Pump time	0.006	1.01	0.03	1.01-1.02

DM, Diabetes mellitus; CVA, Cerebrovascular accident

DISCUSSION

In our investigation, we found that old age, cigarette smoking, diabetes mellitus, longer pump time, longer intubation time, and having a history of CVA were risk factors for prolonged recovery of consciousness after cardiac surgery.

In the current study, the patients who had a history of CVA had prolonged recovery of consciousness from general anesthesia compared with those who had no such history. Baranowska et al [6] showed significant relationships between a history CVA with or without paresis and neurological events after cardiac surgeries. Older age, history of stroke, hypertension, and diabetes are associated with neurological complications followed by delayed consciousness after cardiac surgery. The mechanism of this association is probably related to the status of blood vessels surrounding the brain, coronary arteries, and carotid artery. Intraoperative CVA may result from embolism, thrombosis, or hypoperfusion—which are more common in patients with a history of hyperlipidemia, diabetes, hypertension as well as in patients who probably had plaques in their coronary arteries, aorta, or other main arteries. [7]

Previous studies have shown that age is associated with recovery of consciousness time after cardiac surgery. The mechanisms of this finding seem to be the anatomical and functional areas of the brain participating in consciousness change progressively with age and also alteration of response to anesthetics in the elderly. [8-10] We found that age was associated with delayed consciousness among our study population.

In the current study, diabetes mellitus was significantly associated with recovery of consciousness time. Severe hyperglycemia can prolong unconsciousness after anesthesia because it creates osmotic diuresis and dehydration. Blood hyperosmolality and hyperviscosity predispose to thrombosis and cerebral edema; thus, intraoperative CVA may occur in diabetics with microvascular and macrovascular diseases. [11]

Smoking was another variable significantly associated with delayed consciousness in our study. Hypoxia caused by smoking may result in cerebral hypoxia and ultimately destroy the brain function. Cerebral cells can be damaged by lactic acid production, free radical accumulation, and release of intracellular metabolites. [11]

In our study, the duration of pump time and intubation time had a negative effect on recovery of consciousness time. In other words, the patients who had longer pump or intubation times needed more time to recover consciousness after cardiac surgery. The association between CPB time and intubation time is allied to the pharmacokinetics and pharmacodynamics of anesthetic drugs. Barbosa et al [12] reported that propofol might increase hypnotic effects after cardiac surgery and prolong intubation time. Tasi et al [3] reported that the continuous administration of fentanyl and Dormicum infusion during CPB might be related to an increase in recovery of consciousness time.

CONCLUSIONS

In light of the results of the current study, we can conclude that old age, cigarette smoking, diabetes mellitus, longer pump time, longer intubation time, and having a history of CVA are risk factors for prolonged recovery of consciousness after cardiac surgery. These findings provide noteworthy information for clinicians and anesthesiologists to adjust their anesthetic management based on patients' condition for better care after cardiac surgery.

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