Determination of Factors Related to Perioperative Mortality in Cardiovascular Surgery

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ABSTRACT:

Determination of factors related to perioperative mortality in cardiovascular surgery

Objective: The mortality rate in cardiovascular surgery procedures varies with different centers around the globe. Identification of risk factors for perioperative mortality and establishment of protocols for this may increase survival in patients. In this study, we investigated the mortality rates and corresponding risk factors in cardiovascular surgery.

Material and Methods: A retrospective cohort study was performed in the patients who were admitted to the Cardiovascular Surgery Clinic and died in the perioperative period.

Results: A total of 4037 patients were admitted to the Cardiovascular Surgery Service between January 1, 2013 and December 31, 2016, during four years. In patients treated in intensive care unit, open heart surgery for 567 patients and peripheral vascular disease surgery for 525 patients were planned. Thirty patients who had open heart surgery and 14 patients who had peripheral vascular disease died in perioperative period at the intensive care unit. The general mortality rate in the Cardiovascular Surgery Clinic during this 4-year period was found as 1.1%. The mortality rate of open heart surgery was 5.1% whereas that of peripheral vascular surgery was 2.7%. Hypertension, chronic kidney disease and diabetes mellitus were detected as the most common accompanying systemic diseases. Ejection fraction (EF) was found as 48.4±13.7, Euroscore Additive as 10.0±4.2, cross-clamp time as 125.1±51.9 minutes and cardiopulmonary bypass (CPB) duration as 192.0±81.1 minutes in patients who were lost during open heart surgeries. The APACHE II scores of the patients who were scheduled for peripheral vascular disease and were lost in the perioperative period were detected as 26.1±8.5.

Conclusion: The mortality rate of open heart surgery in our clinic, when compared within the global scale is between developed and emerging countries. Presence of preoperative systemic diseases in cardiovascular surgery patients is significantly correlated with the mortality rate.

Keywords: Cardiovascular surgery, intensive care, mortality, risk factors

ÖZET:

Kalp ve damar cerrahisinde perioperatif mortalite ile ilişkili faktörlerin belirlenmesi

Amaç: Kalp ve damar cerrahisi prosedürleri dünya üzerinde değişik merkezlerde farklı mortalite oranları gösterir. Perioperatif mortaliteye neden olan risk faktörlerinin belirlenmesi ve buna yönelik protokollerin oluşturulması hastalarda sağkalımı arttırabilir. Biz bu araştırmada kalp ve damar cerrahisi mortalite oranlarını ve risk faktörlerini araştırmayı planladık.

Gereç ve Yöntemler: Kalp ve Damar Cerrahisi Kliniği'ne yatan ve perioperatif dönemde ölen hastalarda retrospektif kohort çalışması yapıldı.

Bulgular: Kalp ve Damar Cerrahi Servisi'ne 1 Ocak 2013 ile 31 Aralık 2016 tarihleri arasında dört yıl süresince toplam 4037 hasta yatırıldı. Yoğun bakım ünitesinde tedavi gören hastalar içerisinde 567 hastaya açık kalp cerrahisi ve 525 hastaya periferik damar hastalığı cerrahisi planlandı. Açık kalp cerrahisi geçirenlerden 30 hasta, periferik damar hastalığı olanlardan 14 hasta perioperatif dönemde yoğun bakım ünitesinde kaybedildi. Kalp ve Damar Cerrahisi Kliniği'nin dört yıllık toplam mortalite oranı %1.1 olarak bulundu. Açık kalp cerrahisi geçirenlerin mortalite oranı %5.1 iken periferik damar cerrahisinde %2.7 olarak bulundu. Hipertansiyon, kronik böbrek hastalığı, ve diyabetes mellitusun en sık eşlik eden sistemik hastalıklar olduğu tespit edildi. Açık kalp cerrahisi geçirip sonrasında kaybedilen hastalarda ejeksiyon fraksiyonu (EF) %48.4±13.7, Euroscore Additive 10.0±4.2, kros klemp süresi 125.1±51.9 dakika ve kardiyopulmoner bypass (KPB) süresi 192.0±81.1 dakika olarak bulundu. Periferik damar hastalığı için prosedür planlanan ve perioperatif dönemde kaybedilen hastaların APACHE II skorlarının 26.1±8.5 olduğu tespit edildi.

Sonuç: Kliniğimizin açık kalp cerrahisi mortalite oranı, gelişmiş ülkeler ile gelişmekte olan ülkelerin oranları arasındadır. Kalp ve damar cerrahisi hastalarında preoperatif sistemik hastalıkların varlığı mortalite oranıyla doğrudan ilişkilidir.

Anahtar kelimeler: Kalp ve damar cerrahisi, yoğun bakım, mortalite, risk faktörleri

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INTRODUCTION

Increasing experience of surgical and anesthesia teams nowadays, evidence-based applications, advances in the fields of medical technology and pharmacology allows for a wide variety of procedures in the field of cardiovascular surgery (CVS). However, even in developed centers, perioperative mortality rates in cardiovascular surgery patients are in the range of 1.9-5.3% (1-6). Careful patient evaluation, appropriate surgical approach and good team work are necessary to reduce the perioperative mortality in these patients. Cardiovascular procedures require a specific approach and careful patient follow-up in terms of both surgery and anesthesia.

Open heart surgery is mainly used to correct pathologies arising from coronary artery disease and heart valve diseases. In these patients, primary diagnosis is usually accompanied by hypertension, diabetes mellitus, chronic kidney disease and rhythm disorders. Aortic and vascular disease operations usually involve neurological, cardiac, and pulmonary morbidity risks. These can lead to an increase in mortality in patients (2,3,7,8).

The cardiovascular surgery clinic of our hospital is a center for both open heart surgery and peripheral vascular procedures. In this study, we aimed to investigate the mortality rates and perioperative characteristics of patients who had been treated at CVS clinic for four years, admitted to the intensive care, and lost during follow-up. Detection of mortality and risk factors can lead to the development of safer surgical and anesthesia techniques.

MATERIAL AND METHOD

A retrospective cohort study was performed in patients who had admitted to the Cardiovascular Surgery Clinic and died in the perioperative period. The records of 44 patients who were lost in the intensive care unit from January 1, 2013 to December 31, 2016 were reviewed, following ethical committee approval at a tertiary hospital. The age, gender, classification of American Society of Anesthesiologists (ASA), body mass index (BMI), accompanying diseases, primary diagnosis, Euroscore values,

ejection fraction (EF), preoperative hemoglobin values, amount of blood product transfusion, performed operation, the anesthesia method performed, duration of operation who underwent open heart surgery, duration of pump, duration of cross clamping, whether or not perioperative inotropic treatment was given, whether or not they underwent revision surgery, duration of stay in intensive care unit, major cause of mortality and risk factors related to death were recorded in patients.

Statistical Analysis

All analyses were performed using SPSS (version 21.0) program. Categorical variables were expressed in terms of number and percentage. Normality of the distribution of numerical data was evaluated by histogram analysis. Results were expressed as mean ± standard deviation for normal distribution parameters, and as median value and interquartile range for parameters without normal distribution.

RESULTS

A total of 4037 patients were admitted to the Cardiovascular Surgery Service between January 1, 2013 and December 31, 2016, for four years. Of these patients, 1092 were treated at the CVS Intensive Care Unit (ICU). According to the records of intensive care unit, 567 open heart surgeries and 525 interventions for peripheric vascular disease were aimed at the CVS Intensive Care Unit. Of these patients who were treated at CVS Intensive Care Unit, 30 patients who underwent open heart surgery and 14 patients with peripheral vascular disease were found to have died in ICU. The overall four-year mortality rate of the CVS clinic was calculated as 1.1%. The mortality rate of patients admitted to ICU was found to be 4%.

The total number of patients who underwent open heart surgery in the CVS clinic was 567, while the mortality rate was 5.1%. Of the total 44 patients lost during follow-up in ICU, 14 were operated in emergency conditions and 24 were in elective conditions. One of the patients who died in ICU died in the preoperative period without any surgery, and

29 patients died in the ICU after open heart surgery was performed. The characteristics and other characteristics of patients who underwent open heart surgery are shown in Table-1.

Six (21%) of the patients who had undergone open heart surgery and died at ICU were detected from the records to be ASA II, 1 was ASA IIE (3%), 13 were (45%) ASAIII, 2 were (7%) ASA IIIE, 1 was (3%) ASA IV and 6 were (21%) ASA IVE. One (7%) of the patients who had peripheral vascular disease and died at ICU was detected to be ASA II, 1 was ASA IIE (7%), 4 were ASAIII (29%), 2 were ASA IIIE (14%), 1 was ASA IV (7%), 5 were ASA IVE'si (36%) (Table-1).

Coronary artery disease (35%), coronary artery disease and concomitant mitral insufficiency, ventricular aneurysm or ascendant aortic aneurysm (29%), valve disease (21%), atrial myxoma (3%), aortic pathologies (6%), cardiac gunshot injury (3%) and digoxin toxicity (3%) were found as the most common causes of death in patients who underwent open heart surgery (Table-1).

Hypertension (58%) was the most common comorbid disease in patients who were lost in ICU after open heart surgery, while chronic renal disease (43%) was the second most common and diabetes mellitus (17%) was the third (Table-1). Concomitant diseases were hypertension (64%), chronic kidney disease (57%) and diabetes mellitus (57%) in patients who were lost in ICU after intervention for peripheral vascular disease (Table-3).

In patients who have undergone open heart surgery and lost in ICU, EF was detected as %48.4±13.7, Euroscore Additive as 10.0±4.2, cross clamp time as 125.1±51.9 minutes and CPB time as 192.0±81.1 minutes (Table-2).

Beta blockers, calcium channel blockers, angiotensin converting enzyme inhibitors, angiotensin receptor blockers, diuretics, antiplatelet

Table-1: Characteristics of patients who were lost in ICU after open heart surgery.

Age (Years)	62.6±15.6
Gender	
Male	19 (66%)
Female	10 (34%)
ASA*	
I/IE	0/0
II/IIE	6 (21%) / 1 (3%)
III/IIIE	13 (45%) / 2 (7%)
IV/IVE	1 (3%) / 6 (21%)
BMI†	27.7±4.5
Primary diagnosis	
Coronary artery disease	10 (35%)
Coronary artery disease and mitral insufficiency	4 (15%)
Coronary artery disease and ventricular aneurysm	2 (7%)
Coronary artery disease and ascending aortic aneurysm	2 (7%)
Mitral insufficiency, ventricular aneurysm	2 (7%)
Atrial myxoma	1 (3%)
Mitral insufficiency and tricuspid insufficiency	1 (3%)
Mitral insufficiency, tricuspid insufficiency and ascending aortic aneurysm	3 (11%)
Aortic insufficiency and ascending aortic aneurysm	1 (3%)
Aortic dissection	1 (3%)
Digoxin toxicity	1 (3%)
Cardiac gunshot injury	1 (3%)
Accompanying diseases	
Hipertension	17 (58%)
Chronic renal disease	12 (43%)
COPD	8 (28%)
Hyperlipidemia	7 (24%)
Diabetes Mellitus	5 (17%)
Atrial fibrillation	5 (17%)

Note: The data in the table are expressed as number (%), mean±SD (parameters with normal distribution) or median value and interquartile range (parameters with no normal distribution). *ASA: American Society of Anesthesiologists classification. †BMI: Body mass index

Table-2: Perioperative data of patients who were lost in ICU after open heart surgery.

Ejection fraction (%)	48.4±13.7
Preoperative Hemoglobin (gr/dl)	12.3±2.1
Operation time (Minutes)	328.7±97.6
Cross clamp time (Minutes)	125.1±51.9
Pump time (Minutes)	192.0±81.1
Duration of stay in ICU (Gün)	6.5 (1.0-12.5)
Euroscore (%)	12.9 (7.0-32.6)
Euroscore additive	10.0±4.2
Transfused erythrocyte suspension (n)	7.0 (2.7-12.0)
Transfused fresh frozen plasma (n)	10.0 (5.0-22.2)

Note: The data in the table are expressed as number (%), mean±SD (parameters with normal distribution) or median value and interquartile range (parameters with no normal distribution).

agents and anticoagulant agents were given to the patients who were planned to undergo surgery, when needed. In addition, some medications were given for other accompanying diseases.

All the patients who were lost were in the intensive care unit. Because when these patients became critical they were transferred to CVS intensive care unit. Thus, no deaths were detected in the CVS service (in-hospital).

Among the patients scheduled for surgery due to peripheral vascular disease, the number of patients who were admitted to ICU was 14 and their APACHE II scores were 26.1±8.5. After intervention for peripheral vascular disease, 9 patients were lost, 5 were lost without any intervention. The total number of patients scheduled for peripheral vascular surgery in the CVS clinic was 525, while the mortality rate was 2.7%. The characteristics and other characteristics of patients who underwent intervention for peripheric vascular disease are shown in Table-3.

CONCLUSION

Mortality rates in open heart surgery are related to the level of development of countries and this rate is lower in developed countries. In studies conducted between 1997 and 2001 in the United States,

Table-3: Characteristics and perioperative data of patients who were planned to undergo surgery for peripheral vascular disease and were lost in ICU.

Age (Years)	65.5±10.3
Gender	
Male	9 (64%)
Female	5 (36%)
ASA	
I/IE	0/0
II/IIE	1 (7%) / 1 (7%)
III/IIIE	4 (29%) / 2 (14%)
IV/IVE	1 (7%) / 5 (36%)
BMI	24.5±6.1
Planned surgery	
Percutaneous endovascular intervention	5 (35%)
Embolectomy	4 (29%)
Femoropopliteal bypass	2 (14%)
Abdominal aortic graft repair	2 (14%)
Amputation	1 (7%)
Accompanying diseases	
Hipertension	9 (64%)
Chronic renal disease	8 (57%)
Diabetes Mellitus	8 (57%)
Hyperlipidemia	7 (50%)
COPD	1 (7%)
Preoperative Hemoglobin (gr/dl)	12.0±2.2
Operation time (Minutes)	162.0±59.3
Duration of stay in ICU (Days)	1 (1-3)
Transfused erythrocyte suspension (n)	0 (0-2.2)
Transfused fresh frozen plasma (n)	0 (0-0.75)
APACHE II score	26.1±8.5

Note: The data in the table are expressed as number (%), mean±SD (parameters with normal distribution) or median value and interquartile range (parameters with no normal distribution).

mortality rates for coronary artery bypass grafting (CABG) surgeries ranged between 1-5% (1-3). In Brazil, which is one of the emerging countries, CABG mortality rate between 2000 and 2003 was reported to be 7% (9). The open heart surgery mortality rate of our clinic was detected as 5.1%, which is between the rates of developed and emerging countries.

Concomitant diseases in patients who underwent open heart surgery are directly related to the mortality rate (2,3,7,8). The ASA physical classification is a method recommended by the American Society of Anesthesiologists to assess patients' pre-operative health status. Patients with severe systemic diseases that does not affect daily activities are classified as ASA III, whereas ASA IV patients are those with severe systemic diseases that are life-threatening and affecting daily activities (10). In our study, it was once again shown that ASA classification was a predictor of life-threatening risks, and it was found that 76% of patients who underwent open heart surgery and died in ICU were ASA III and ASA IV patients.

Euroscore is used to determine perioperative mortality risk during cardiothoracic surgery. While the mortality rate increases as Euroscore values increase, the rate decreases as this value decreases (11-13). A study conducted in 4497 patients who underwent isolated CABG surgery reported that Euroscore assessment was a good method to estimate 30-day mortality (4). In our patients who underwent open heart surgery and died in ICU, the Euroscore values (Percent value 12.9%, Additive value 10.0±4.2) were quite high.

Preoperative low EF in cardiac surgery is associated with mortality. In a study evaluating left ventricular EF of 7313 patients who underwent cardiac surgery, low EF values were associated with high perioperative mortality in patients undergoing mitral valve surgery (14). In a prospective observational study with 8600 patients who underwent CABG, patients with EF greater than 40% had mortality of less than 2%, 3.5-4% in patients with 20-40% EF and 8% in patients with less than 20% (15). In our study, mean EF values were found as 48.4±13.7 in patients who died in the perioperative period. We expected that EF values would be lower in patients who died, but other factors affecting mortality might have come to the forefront.

There are some outcomes about blood and blood products with long-term storages that they may cause structural and functional changes in patients. In a retrospective study with 6000 patients, prolonged intubation time, renal insufficiency, sepsis and high mortality were found to be associated with blood products with longer storage times than 14 days (16). In our study we also used stored erythrocyte suspension and fresh frozen plasma in especially patients who underwent open heart surgery. We believe that the stored blood products has contributed toour mortality rate.

Perioperative complication risk in peripheral vascular surgery is high. Complications are greater in the large diameter vessels and the operations over the inguinal region, than in the small diameter vessels and in the infrainguinal region. In a retrospective cohort study of 3202 patients who underwent peripheral vascular surgeries performed in Denmark between 2005 and 2012, the overall complication rate was 30%, the wound complication was 19%, the surgical complications were 6%, and the general complications were 10%. Advanced age, cardiac and renal disease, high ASA score and general anesthetics were found as the greatest risk factors in the development of complications. Thirty-day mortality was reported as 5% (17). In this study, the authors suggested that cardiac and renal status should be optimized before surgery, and local or regional anesthesia should be performed if possible. Our patients with peripheral vascular pathology are also mostly elderly and their general condition is poor. These patients are mostly with ASA scores III and IV, and their primary pathology is associated with many systemic diseases. However, our mortality rate was 2.7%, which was lower than the study performed in Denmark.

Percutaneous endovascular interventions are frequently performed as peripheral vascular surgery in our clinic. We prefer to use local anesthesia and monitorized anesthesia care most frequently in these surgeries. Regional anesthesia could not be performed because clopidogrel and acetyl salicylic acid could not be withdrawn due to cardiovascular

problems in patients whom percutaneous intervention couldn't be performed, whereas peripheral vascular grafting and femoropopliteal bypass were performed. Regional anesthesia techniques such as epidural and spinal anesthesia may cause bleeding risks in these patients who are using these antiplatelet agents (18,19). We preferred laryngeal mask anesthesia where the risks of general anesthesia are less visible in these patients.

The APACHE II scoring system is an accepted scoring system for determining the expected mortality rate in intensive care units (20). The APACHE II scores were found high among our patients with peripheral vascular disease who were lost perioperatively in ICU.

In conclusion, our clinic's open heart surgery mortality rate is acceptable when compared with other centers. Concomitant systemic diseases are the most important risk factors that increase mortality. Preoperative preparation should be done with caution and possible complications should be anticipated. The patients should be operated after they are physiologically optimized.

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