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Araştırma

Preoperative Evaluation of The Patients with Cardiovascular Disease Undergoing Noncardiac Surgery

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ABSTRACT

Objective: *Preoperative evaluation of the patients with cardiac problems who will undergo noncardiac surgery is crucial. The aim of our study is to investigate the relationship between cardiac risk determined by the American Society of Anesthesiologists (ASA) classification, Goldman scoring system, and the cardiology consultation, and the perioperative mortality and morbidity.*

Material and Method: *Five hundred patients undergoing noncardiac surgery for whom cardiology consultation requested were studied prospectively. The relationship between the patients' ASA classes, Goldman scores, cardiac risks, comorbidities, operation types, preoperative cardiac symptoms, and perioperative morbidity and mortality was assessed.*

Results: *The mean age in the group with morbidity (69.3±10.6 years) was significantly higher than that in the group without morbidity (64.0±12.1 years) (p<0.001). There was no perioperative mortality while in 354 (70.8%) of 500 patients cardiovascular complications developed.While a significant difference between operation type of both groups was observed (p=0.001), preoperative hypertension was more frequently seen in the morbidity group (p=0.007). Preoperative ASA classes (p=0.016), Goldman scores (p<0.001), and cardiac risks of patients (p=0.039) were significantly different between the groups. Logistic regression analysis was applied, and only age, hypertension, and operation type were found to be risk factors for perioperative morbidity.*

Conclusion: *We believe that ASA classification, Goldman Cardiac Risk Index, and cardiac risk determined by the cardiologists can affect the patients' perioperative management . Besides use of risk indices and algorithms can reduce the requirement for consultation and request for unnecessary laboratory or imaging tests and can prevent unnecessary cancellation or delaying of the surgery.*

Keywords: *preoperative evaluation, noncardiac surgery, ASA classification, Goldman cardiac risk index*

ÖZ

Nonkardiyak Cerrahi Geçirecek Kardiyovasküler Hastalığı Olan Hastaların Preoperatif Değerlendirilmesi

Amaç: *Nonkardiyak cerrahi geçirecek kardiyak sorunlu hastaların preoperatif değerlendirmesi oldukça kritiktir. Çalışmamızın amacı, Amerikan Anestezistler Derneği (ASA) sınıflaması, Goldman skorlama sistemi ve kardiyoloji konsültasyonu ile belirlenen kardiyak risk ile perioperative mortalite ve morbidite arasındaki ilişkinin araştırılmasıdır.*

Gereç ve Yöntem: *Nonkardiyak cerrahi geçirecek, kardiyoloji konsültasyonu istenen 500 hasta prospektif olarak çalışmaya alındı. Hastaların ASA sınıfları, Goldman skorları, kardiyak riskleri, komorbiditeleri, operasyon tipleri, preoperative kardiyak semptomları ile perioperative mortalite ve morbidite arasındaki ilişki değerlendirildi.*

Bulgular: *Morbidite gelişen grupta ortalama yaş (69.3±10.6) morbidite gelişmeyen gruba göre (64.0±12.1) anlamlı olarak yüksekti (p<0.001). Çalışmamızda perioperative mortalite gözlenmezken, 500 hastanın 354 (%70,8) ünde kardiyovasküler komplikasyon gelişti. Ameliyat tipi açısından iki grup arasında anlamlı farklılık gözlenirken (p=0.001), preoperatif hipertansiyon varlığı morbidite gelişen grupta daha sıktı (p=0.007). İki grubun preoperatif ASA sınıfları (p=0.016), Goldman skorları (p<0.001) ve kardiyoloji konsültasyon riskleri (p=0.039) anlamlı olarak farklıydı. Yapılan lojistik regresyon analizinde yalnızca yaş, hipertansiyon ve operasyon tipinin perioperative morbidite için risk faktörü olabileceği gösterildi.*

Sonuç: *ASA sınıflaması, Goldman kardiyak risk indeksi ve kardiyolog tarafından belirlenen kardiyak risk, hastaların perioperatif yönetimini etkileyebilir. Ayrıca risk indeksleri ile algoritimlerin kullanımının, konsültasyon gereksinimini azaltarak gereksiz laboratuvar ve görüntüleme tetkiki istemini dolayısıyla cerrahinin gereksiz ertelenme ve iptalini önleyebileceğini düşünüyoruz.*

Anahtar kelimeler: *preoperatif değerlendirme, nonkardiyak cerrahi, ASA sınıflaması, Goldman kardiyak risk indeksi*

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INTRODUCTION

During the previous few decades, noncardiac surgery has made substantial advances in treating diseases and improving the patient's quality of life. Thus, the number of elderly patients undergoing noncardiac surgery

is growing worldwide [1]. However, such surgery is associated with significant cardiac morbidity, mortality, and consequent cost. By contrast, preoperative risk assessment is an important step here, and the goals of preoperative evaluation are to reduce patient risk and morbidity of surgery as well as to promote efficiency and reduce cost [2].

Preoperative evaluation has several components and goals. The most important parameters of the evaluation are history and physical examination. Based on the history and physical examination, appropriate laboratory tests and preoperative consultations should be provided. Based on the above-mentioned parameters, the anesthesiologist should choose the appropriate anesthetic and care plan.

In recent decades, several classification systems have been developed to assess the cardiac risk. The American Society of Anesthesiologists (ASA) classification is used to predict cardiac death within 48 hours of surgery [3]. However, the ASA classification system has limited utility because it is very subjective and its reproducibility has not been proven uniformly. In addition, the ASA system is not as efficient as the other indices, particularly for predicting cardiac events [4]. The Goldman Cardiac Risk Index and Detsky Risk Index are multifactorial approaches for risk assessment that were developed to overcome the limitations of the ASA classification system [5,6]. Lee at al. prospectively produced the revised cardiac risk index stratification system in an attempt to simplify the Goldman Index [7]. The 1996 American College of Cardiology/ American Heart Association (ACC/AHA) Guidelines on perioperative cardiovascular evaluation for noncardiac surgery provide an evidence-based approach for the perioperative evaluation and management of these patients which were updated in 2002, 2007, and 2014 [8].

Although cardiac complications are the most extensively studied subject in perioperative medicine [9], prospective studies that assess and directly compare the accuracy of different risk indices that are currently used in large populations are still lacking [10]. We attempted to determine the validity of the ASA system, Goldman scores, and cardiology consultation based on the ACC/AHA guidelines for predicting the perioperative mortality and morbidity in 500 consecutive patients scheduled for elective noncardiac surgery.

MATERIAL and METHODS

Preoperative period

Patients scheduled for elective non-cardiac surgery at the Baskent University Hospital were evaluated by a cardiologist and an anesthesiology resident under the supervision of a senior anesthesiologist. The cardiac risk was determined by the cardiologist according to the ACC/AHA guidelines. The parameters included in the evaluation and examination schedule are presented in Table 1.

Table 1. Preoperative data.

- Age
- Sex
- Type of surgery
- Patient's history (angina, dyspnea, syncope, orthopnea, arrhythmia)
- Physical examination
- Routine laboratory tests
- Comorbid diseases
- ASA scores
- Goldman scores
- Cardiology risks

The Goldman Cardiac Risk Index and the ASA scores are based on the anamnesis data, physical examination, and complementary tests. The parameters included in the Goldman and ASA scores are shown in Tables 2 and 3.

Table 2. Physical status of the patients as classified by the ASA.

ASA classification	Patient's physical status
I	Normal and healthy
II	Mild systemic disease
III	Severe systemic disease that limits activity but is not incapacitating
IV	Severe systemic disease that is incapacitating and a constant threat to life
V	Survival for more than 24 h not expected, with or without operation
VI	Brain death
E	Emergency operation requirement

According to the original recommendations, the Goldman Cardiac Risk Index was divided into four groups as follows: Group I, < 6 points; Group II, 6-12 points; Group III, 13-25 points; and Group IV, > 25 points.

Table 3. Goldman Cardiac Risk Index.

Clinical condition	Index points
Age > 70 years	5
Abdominal or thoracic surgery	3
Myocardial infarction within the previous 6 months	10
Third heart sound or jugular vein distention	11
Urgency	4
Hemodynamically significant valvular aortic stenosis	3
Rhythm other than sinus or premature atrial contractions on latest ECG	7
> 5 premature ventricular contractions/min	7
Poor general medical condition: pO < 60, pCO_2 > 50, K < 3, HCO_3 < 20, BUN > 50, Crea > 3, chronic liver disease, confined to the bed	3

Table 4. Recorded intraoperative and postoperative parameters and morbidities.

- Anesthesia type and agents
- Vital signs (blood pressure, heart rate, SpO_2)
- Hemodynamic problems and interventions
- Bleeding and transfusion requirement
- AMI and cardiac arrest

Intraoperative and postoperative period

As part of routine practice, pulse oximetry, electrocardiography, noninvasive blood pressure, and end-tidal carbon dioxide ($ETCO_2$) values were monitored continuously throughout the operation. Invasive blood pressure, central venous pressure, body temperature, and urine output were also monitored if required (in high-risk or surgery patients).

In the general anesthesia group, anesthesia was induced with propofol/thiopental/etomidate as well as vecuronium/rocuronium and fentanyl and maintained with isoflurane and N_2O/O_2. Marcaine, prilocaine, or heavy marcaine were administered in the regional anesthesia group. Patients were premedicated with midazolam and fentanyl in the sedo-analgesia group. The parameters evaluated during intraoperative period and at postoperative 24 hour follow up are shown in Table 4.

While increased systolic, and diastolic blood pressure levels (>140 mmHg, and > 90 mmHg, respectively) were classified as hypertension, systolic pressure <90 mmHg was classified as hypotension. Tachycardia (heart rate > 100) and bradycardia (heart rate < 50) were also recorded. However, temporary increases and decreases did not necessitate any treatment during induction, and laryngoscopes were removed.

After the surgery, patients were transported to their rooms or the intensive care unit (ICU). The same parameters were recorded during postoperative 24 hours. However, if they were transported to the ICU, their follow-up was extended until their discharge from the ICU.

Statistical analyses

All data were presented as mean (± standard deviation) values. SPSS 13.0 for Windows statistical package (SPSS Inc., Chicago, IL, USA) was used for analyses. The variables within the groups with and without morbidity were analyzed using Student - t and chi-square tests. A value of $P < 0.05$ was considered to be statistically significant.

RESULTS

In all, 500 patients were included in the study. Mean (± SD) age of the patients was 67.6±11.3 years. The study population included 273 (54.6%) female, and 227 (45.4%) male patients. The patients were divided into two groups based on the presence or absence of morbidity (ie.hemodynamic complications).

The mean age in the group with morbidity (69.3 ± 10.6 years) was significantly higher than that in the group without (64.0±12.1 years) ($p<0.001$). The men/women ratio was similar in both groups ($p=0.200$). Hemodynamic complications, such as hypotension, hypertension, bradycardia, tachycardia, arrhythmia, acute myocardial infarction (AMI), and cardiac arrest were observed in 354 (70.8%) patients during the perioperative period. Cardiac arrest occurred during the perioperative (n=2), intraoperative (n=1), postoperative (n=1) periods. There was no mortality in

our study. Hypertension, as a comorbid disease, was significantly more prevalent in the morbidity group (57.0%) relative to those without (20.2%) (p=0.007). The prevalence of other comorbid diseases, such as congestive heart failure, valvular disease, arrhythmia, coronary artery disease (CAD), diabetes mellitus, as well as renal and lung diseases was similar between the groups.

There were no statistically significant differences between the groups with respect to the anesthesia type (general anesthesia, regional anesthesia, and sedoanalgesia) and hypnotic agents (thiopental, propofol, and etomidate) used. The history of exertional angina was significantly higher in the morbidity group (p = 0.05). The parameters including other cardiac history are shown in Table 5.

Table 5. Preoperative cardiac history.

	Group A (with morbidity)	Group B (without morbidity)	P value
Angina	20 (5.6%)	5 (3.4%)	0.371
Effort angina	17 (4.8%)	2 (1.4%)	0.05
Orthopnea	21 (5.9%)	7 (4.8%)	0.676
Palpitation	47 (13.3%)	18 (12.3%)	0.884
Dyspnea	25 (7.1%)	9 (6.2%)	0.846
Effort dyspnea	103 (29.1%)	37 (25.3%)	0.444
PND	8 (2.3%)	0 (0%)	0.112
Syncope	2 (0.6%)	2 (1.4%)	0.584

ASA classification scores, Goldman Cardiac Risk scores, and Goldman Cardiac risk group values of the two groups were significantly different, as shown in Figure 1.

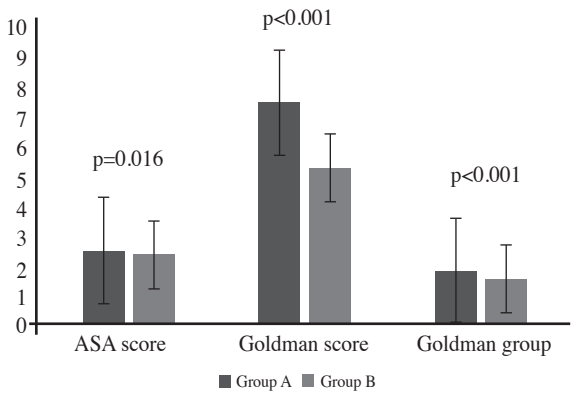


Figure 1. ASA, Goldman scores, and Goldman group values between the groups.

Cardiac risks, as determined preoperatively by a cardiologist based on the AHA/ACC Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery, were significantly higher in the morbidity group (p=0.039).

As a multivariate test, logistic regression analysis was applied. Among all variables, only age, hypertension status, and operation type (abdominal surgery, orthopedic surgery, disc surgery, and craniotomy) emerged as risk factors for perioperative morbidity, as seen in Table 6.

Table 6. Risk factors for perioperative morbidity.

	P value	Odds Ratio
Age	**0.002**	1.04
Abdominal surgery	**0.012**	2.40
Orthopedic surgery	**0.001**	3.22
Disc surgery	**0.012**	2.37
Craniotomy	**0.026**	4.70
Hypertension	**0.018**	0.53
ASA class	0.331	-
Goldman score	0.798	1.01
Goldman group	0.249	-
Effort angina	0.284	0.41
Cardiology risk (AHA/ACC)	0.839	-

CONCLUSION

Cardiac complications and hemodynamic problems are commonly observed during the perioperative period. There are several clinical investigations that describe a correlation between different risk indices and perioperative mortality and morbidity. In our study, we investigated 500 patients undergoing preoperative cardiac assessment for possible noncardiac surgical procedures, and we compared the performance of the ASA classification, Goldman Cardiac Risk Index, and cardiology risk in predicting cardiac events. The results of our study demonstrate a relationship between the age, operation type, hypertension status, presence of exertional angina, and perioperative morbidity. The ASA classification, Goldman Cardiac Risk Index, and cardiology assessment have predictive values for perioperative cardiac events. Further, we found that the prevalence of complications (70.8%) was much greater than in previous studies because we also considered minor complications, such as hypotension, hypertension, bradycardia, and tachycardia in addition to major complications (AMI, ventricular fibril-

lation, heart failure, cardiac arrest, atrioventricular block) that were referred as cardiac events in previous trials.

Patients with CAD are now living longer owing to major medical advances [11]. Therefore, patients carrying high burden of CAD are now surviving long enough for other conditions to develop that require surgical intervention, including cancer and severe osteoarthritis of the hip and knee. The population of the elderly that needs noncardiac surgery is on the rise; therefore, anesthesiologists and surgeons are being consulted by an increasing number of elderly patients.

Advanced age is a special risk factor, not only because of the increased likelihood of CAD, but also because of the effects of aging on the myocardium. Advanced age has been associated with CAD and perioperative complications in multiple studies [5,6,12]. The predictors of perioperative mortality and morbidity determined by Lee et al. [7] do not include advanced age, and the AHA/ACC 2007 Noncardiac Surgery Guidelines mention advanced age as a minor predictor. In our study, we found that the mean age of the morbidity group was higher, and advanced age was an independent risk factor for perioperative complications.

In a study by Castelli et al, premenopausal women had a lower CAD incidence, and in general, symptomatic CAD occurred ≥ 10 years later in women than in men [13]. Thus, male sex can be considered as a risk factor for cardiac complications. However, similar to that in our study, in several other studies [5-7], the ASA classification and AHA/ACC guidelines have not shown a relationship between sex and perioperative morbidity.

For elective surgery, the cardiac risk can be stratified according to several factors, including complexity of surgical procedures. Immediate surgical interventions rather than elective surgery are required in high-risk groups with higher morbidity ratios [5.6,14]. Several large surveys have demonstrated that perioperative cardiac morbidity is particularly concentrated among patients who undergo major thoracic, abdominal, or vascular surgery [14-16]. In our study, we did not include urgent or vascular surgery and found that abdominal, orthopedic, and disc surgery and craniotomy were independent risk factors for cardiac complications. Thoracic surgery was not shown to be a risk factor, and we believe that this result can be attributed to the small number of thoracic surgery cases in our study.

Numerous studies [5,17-21] have shown that stage 1 or stage 2 hypertension (systolic blood pressure <180 mm Hg and diastolic blood pressure < 110 mm Hg) is not an independent risk factor for perioperative cardiovascular complications. However, in some studies [22,23], an elevated blood pressure on an initial recording in a patient with previously undiagnosed or untreated hypertension was shown to be correlated with blood pressure liability under anesthesia. In our study, we found hypertension to be an independent risk factor; however, the limitation of our study was the undefined stage of hypertension mentioned.

Heart failure has been identified in several studies as being associated with a poorer outcome when noncardiac surgery is performed [5-7]. Valvular heart disease, especially severe aortic and mitral stenosis, poses the greatest risk for noncardiac surgery [24,25]. We did not find a relationship between heart failure, valvular disease, and cardiac complications in our study. However, the number of patients with heart failure or valvular disease was very small in our study which might have affected our results.

Several metabolic diseases may accompany cardiac diseases. Diabetes mellitus is the most common of these, and several studies have shown diabetes mellitus to be a risk factor for cardiac complications [26,27]. However, similar to our results, previous reports have not identified diabetes mellitus as a risk factor [7,28].

The predictive power of the Goldman's Cardiac Risk Index and ASA classification for perioperative complications has been evaluated in several prospective studies [5,6,15]. In comparison to those of the ASA classification, the admission terms of the Goldman's Cardiac Risk Index are very restrictive. In a prospective study on 845 consecutive patients scheduled for major elective noncardiac thoracic surgery, the ASA score was a valid method for determining the perioperative risk, and the cardiac risk index did not provide any additional information regarding the general perioperative risk [29].

Cardiology consultations are often recommended by

surgeons and anesthesiologists for patients with cardiovascular disease. Several studies have shown that there is considerable disagreement among anesthesiologists and surgeons regarding the purposes and utility of cardiology consultations [30]. These studies have also suggested that most of the cardiology consultations provide little contribution that actually affects disease management. In our study, we found a correlation between the ASA classification, Goldman Cardiac Risk Index, cardiology consultation risk, and perioperative complications; however, none of these parameters was found to be an independent risk factor. Furthermore, we found that 19.5% of the patients were referred to a cardiologist for any reason by the anesthesiologist or the surgeon. We believe that this is a considerably high percentage; similar high percentages have been reported in previous trials. The use of risk indices and guidelines can reduce the cardiology consultation rates and costs. However, further studies are warranted to establish an ideal method for clinical prediction of cardiac complications.

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