Predictive Factors of Supraventricular Arrhythmias after Noncardiac Thoracic Surgery: A Multicenter Study

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ABSTRACT

Background: Supraventricular cardiac arrhythmias are the most common rhythm disturbances in patients following thoracic surgery. The purpose of our study was to determine which of the clinical parameters are the most valuable in predicting postoperative atrial fibrillation (AF) after lung surgery.

Methods: Retrospective analysis was carried out on 987 patients after noncardiac thoracic surgery to define the prevalence, associated risk factors, and clinical course of postoperative arrhythmias. There were 822 men and 165 women, age 34 to 78 years (mean age: 61 ± 8 years). The patients were divided into two groups depending on the occurrence or absence of supraventricular arrhythmia. Group I consisted of 876 patients who were free from rhythm disturbances. The remaining 111 patients exhibited episodes of supraventricular arrhythmia (29 supraventricular tachycardia; 82 AF). These 111 patients were placed in Group II. Preoperative, operative, and postoperative data were reviewed. Statistical analysis was performed.

Results: A statistically significant difference was found between the two groups in age, previous history of heart disease, and lung resection, especially pneumonectomy. Conclusion: Age, history of prior heart disease, lung resection, and the extent of pulmonary resection are the main risk factors for postoperative supraventricular arrhythmia in patients undergoing major thoracic operations.

INTRODUCTION

Thoracic surgery remains a high-risk procedure for many patients, and supraventricular cardiac arrhythmias, especially atrial fibrillation (AF), are the most common rhythm disturbances in this patient population [Vaporciyan 2004; Bobbio 2007; Von Knorring 1992; Neragi-Miandoab 2008]. Arrhythmias are associated with higher morbidity and longer hospital stay and, therefore, higher hospital costs, as well as with increased perioperative mortality and worse long-term survival [Ziomek 1993; Dyszkiewicz 1998; Krowka 1987; Gómez-Caro 2006]. The etiology of these complications following thoracotomy is still not clearly understood, although several factors are likely to be involved including change in hemodynamics of the right heart, violation of chest cavity, operative stress, pain leading to increased sympathetic activity, and irritation of the epicardium following violation of the pericardium and patch repair after extra pleural pneumonectomy. Other risk factors include myocardial infarction, presence of coronary artery disease, and postoperative lung embolism. Few reports have analyzed risk factors associated with major complications or cardiac arrhythmias [Vaporciyan 2004; Neragi-Miandoab 2008; Rena 2001]. The main aim of our study was to ascertain whether there are factors that predispose to postoperative atrial fibrillation and, if so, how important they are from a clinical standpoint.

PATIENTS AND METHODS

987 patients who had undergone noncardiac thoracic surgery at three thoracic surgery departments between January 2004 and December 2013 were retrospectively analyzed to define the prevalence, associated risk factors, and clinical course of postoperative arrhythmias.

Exclusion criteria were: history of paroxysmal supraventricular arrhythmia in the last 3 months, non-sinus rhythm on admission ECG, and incomplete preoperative or postoperative data.

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In both groups, we analyzed the patient's age, sex, and some elements of clinical history such as history of cardiovascular problems, hypertension, diabetes, tobacco smoking, and preoperative medications. Laboratory data (included those

Table 1. Patient Characteristics

	Group I (n = 876)	Group II (n = 111)	P
Age, mean ± SD	51.4 ± 9.8	69.3 ± 10.5	.03†
Male/Female, n	727/149	95/16	.71
Smoking, n (%)	371 (42.4)	52 (46.8)	.5
Comorbid conditions, n (%)			
COPD	84 (9.6)	12 (10.8)	.19
Hypertension	113 (12.9)	15 (13.5)	.73
Heart disease*	147 (16.8)	29 (26.1)	.04†
Diabetes mellitus	27 (3.1)	5 (4.5)	.55
Intraoperative data, n (%)			
Lengthy operation (>2 h)	249 (28.4)	39 (35.1)	.49
Oxygen saturation <90%	107 (12.2)	11 (9.9)	.73
Hypertension (>180 mmHg)	38 (4.3)	8 (6.2)	.31
Hypotension (<60 mmHg)	25 (28.5)	4 (36)	.52
Bradycardia (<50)	57 (6.5)	13 (11.7)	.08
Tachycardia (>180)	28 (3.2)	4 (3.6)	.59
Estimated blood loss, mL	221 ± 175	235 ± 265	.37
Lung resection, n (%)	291 (33.22)	72 (64.86)	.001†
Lobectomy	52 (5.9)	9 (8.11)	.86
Wedge resection	118 (13.5)	10 (9)	.10
Pneumonectomy	121 (13.8)	53 (47.75)	.001†
Other thoracic surgery (no resection)	585 (66.8)	39 (35.14)	.001†

*Heart disease was defined as history of myocardial infarction, coronary artery disease, or heart failure.

†Statistically significant.

for serum electrolytes, cardiac enzymes, arterial blood gases, and hemoglobin), chest x-rays, ultrasonography of the abdomen, standard 12-lead electrocardiography, spirometry, and pulmonary function test were reviewed.

Surgical records were reviewed and focused on the type of surgical procedure, duration of the operation, variations in the oxygen saturation, systemic hypotension (decrease of more than 30% of initial value), hypertension (over 180 mmHg), bradycardia (<50), tachycardia (>140), or cardiac arrest.

After surgery, patients were transferred to a general intensive care unit (ICU) for the first 12/24 hours. Routine continuous ECG monitoring was conducted in the ICU and, if necessary, in the ward during the perioperative period. ECG recording was started immediately after the onset of arrhythmia. A cardiologist consultant interpreted each ECG.

Postoperative Follow-up

Follow-up information was recorded for postoperative complications, especially hemorrhage and the need for rethoracotomy, atelectasis, or pulmonary edema, and the mortality rate in both groups was also investigated. Finally, new onset of arrhythmias was identified by continuous ECG monitoring in the first postoperative hours and thereafter by physicians' and nurses' clinical controls, and then confirmed by a 12-lead ECG.

Pharmacological treatment and side effects related to the use of antiarrhythmic drugs were recorded. No patient received prophylactic antiarrhythmic drugs. Once atrial fibrillation was diagnosed, immediate treatment was introduced. Firstly, special care was taken to maintain potassium levels above 4 mmol/L. Additionally, magnesium sulphate (2.0-4.0 g/day) was administered by continuous drip. We were able to restore stable sinus rhythm using b-blockers for supraventricular tachycardia and amiodarone for AF patients.

Statistical Analysis

All data were collected, organized, tabulated, and statistically analyzed using SPSS software statistical computer package version 13 (SPSS, Chicago, Illinois, USA). For quantitative data, the range, mean, and standard deviation were calculated. For qualitative data, comparison between the two groups was done using and χ^2 test. Correlation between variables was evaluated. Significance was adopted at $P < .05$ for interpretation of results of tests of significance.

RESULTS

The study comprised 987 consecutive patients whose age ranged from 34 to 78 years (mean 61 ± 8 years, median 62 years). There were 822 men and 165 women.

The patients affected by supraventricular arrhythmia in the preoperative period were excluded from the study; the remaining 987 who had no preoperative ECG signs of rhythm disturbances were retrospectively investigated for risk factors that could increase incidence of postoperative arrhythmia.

There were significant differences between the two study groups in age distribution, with increasing incidence of supraventricular arrhythmia with increasing age ($P = .03$). There were no significant differences between the two study groups with respect to other demographic characteristics. There were no differences between patients with or without postoperative supraventricular arrhythmia in regard to the prevalence of hypertension, diabetes, and pulmonary diseases.

Supraventricular arrhythmia was significantly more frequent in patients with a history of prior heart disease ($P = .04$) (Table 1).

Supraventricular arrhythmia was significantly less frequent in patients who underwent thoracic surgery other than resection and significantly more frequent in patients with lung resection. This means that lung resection is the main risk factor for postoperative supraventricular arrhythmia. Also, a greater extent of pulmonary resection (pneumonectomy) significantly increased the prevalence of supraventricular arrhythmia ($P = .001$). There was no significant difference between the two groups in regard to the remaining intraoperative data (Table 1).

Table 2. Postoperative Morbidity and Mortality

	Group I (n = 876)	Group II (n = 111)	P
Hypotension (<90 mmHg)	267 (30.5%)	34 (30.6%)	.98
Respiratory complications*	151 (17.2%)	17 (15.3%)	.37
Wound dehiscence	4 (0.46%)	1 (0.9%)	.43
Rethoracotomy	9 (1.03%)	2 (1.8%)	.09
Postoperative O2 sat, %	95.06 ± 3.52	94.86 ± 2.61	.93
Mortality	12 (1.4%)	3 (2.7%)	.07

*Respiratory complications were defined as adult respiratory distress syndrome (ARDS), pneumonia, pulmonary fibrosis, or atelectasis requiring bronchoscopy and/or reintubation.

All episodes of supraventricular arrhythmia were managed by pharmacological treatment (no patients required electrical cardioversion). All patients returned to sinus rhythm during hospitalization.

There was no significant difference between the two groups regarding postoperative morbidity/mortality. Fifteen of our patients died. Causes of death were pneumonia (n = 4), acute myocardial infarction (n = 2), bronchial fistula (n = 3), adult respiratory distress syndrome (n = 4), and pulmonary thromboembolism (n = 2). Only 3 of the patients who developed AF died, though the difference in mortality between patients with and without supraventricular arrhythmia was not statistically significant. In none of the cases did supraventricular arrhythmia determine cardiovascular failure necessitating the death (Table 2).

DISCUSSION

Despite improvements in surgical and anesthesiological techniques, the incidence of supraventricular arrhythmias after noncardiac general thoracic surgical procedures has remained substantially unchanged over the past two decades, and remains one of the most frequent complications [Imperatori 2012; Ciriaco 2000; Onaitis 2010].

Previous attempts have been made to identify factors associated with the development of supraventricular arrhythmias after noncardiac thoracic surgery. Although most have examined specific subgroups of patients undergoing pulmonary resection, primarily for lung cancer [Dyszkiewicz 1998; Rena 2001; Cardinale 1999] or esophagectomy [Amar 1996], a few investigators have examined a broader population of patients similar to our patient population [Amar 2002; Asamura 1993; Polanczyk 1998].

Previously stated risk factors for the development of supraventricular arrhythmias after noncardiac thoracic surgery include increasing age; male gender; history of hypertension; previous history of cardiac disease; malignant disease; preoperative pulmonary functional test; anesthetic agents; size of procedure; extent of pulmonary resection; mediastinal lymph node dissection; intrapericardial pneumonectomy; intraoperative cardiac arrest; intraoperative blood transfusions; electrolyte imbalance; and pulmonary complications and need for repeat thoracotomy. Many authors held differing opinions on these factors [Vaporciyan 2004; Harpole 1996; Anile 2012].

This study identified age; male gender; history of smoking; a previous history of comorbid conditions (COPD, hypertension, heart disease, or diabetes mellitus); and intraoperative data (lengthy operation, oxygen saturation, hypertension, hypotension, bradycardia, tachycardia, the procedure performed, and estimated blood loss) as predictors of postoperative supraventricular arrhythmias. Postoperative morbidity and mortality were also identified.

The patients evaluated in this study represented a broad spectrum of general thoracic surgical patients. A wide variety of diagnoses and procedures were examined, which allows generalization of these results to general thoracic practices.

Our 12.25% overall incidence of supraventricular arrhythmias was similar to that in other published reports [Amar 2002; Asamura 1993]. It differed from reports by others [Rena 2001].

The association between age and supraventricular arrhythmias was closely examined in many series [Neragi-Miandoab 2008; Rena 2001; Lanza 2003]. The findings were similar to our results, which support the association of increasing incidence of supraventricular arrhythmias with increasing age.

In our study, sex was not found to be a predictor for the development of arrhythmia after thoracic surgery. The association between male sex and supraventricular arrhythmias has not been commonly identified by previous investigators [Vaporciyan 2004; Rena 2001]. The multivariate analysis of others has identified male sex as a predictor of supraventricular arrhythmias [Imperatori 2012; Polanczyk 1998].

Our study demonstrated associations of cardiac disease with supraventricular arrhythmias. The association of cardiac disease with supraventricular arrhythmias has been demonstrated inconsistently by other investigators [Dyszkiewicz 1998; Ciriaco 2000; Asamura 1993]. The selection criteria imposed by thoracic surgeons might prevent patients with clinically relevant cardiac disease from undergoing surgical intervention. The common occurrence of arrhythmias after cardiac surgery supports the association of cardiac disease with arrhythmias after thoracic surgery [Ellenbogen 1991; Podrid 1999].

The lack of association between hypertension and arrhythmias in our analysis is also noteworthy. Other investigators have shown this association (3,13).

The presence of COPD was not associated with the development of arrhythmias in our study. Other investigators have found that the association between COPD and arrhythmias is inconsistent [Krowka 1987; Sekine 2001]. The definition of COPD might vary between different authors and might lead to this inconsistency. Our definition was based on the presence or absence of bronchodilator treatment and not strict pulmonary function testing.

The association between the extent of pulmonary resection and supraventricular arrhythmias has been identified by a number of investigators. They have found the highest

incidence of supraventricular arrhythmias to be after pneumonectomy [Dyszkiewicz 1998; Ciriaco 2000; Asamura 1993]. We substantiate this finding in our study, where the incidence of supraventricular arrhythmias was significantly higher after lung resection and more so after pneumonectomy (P = .001).

Besides pneumonectomy, the need for rethoracotomy also contributed significantly to supraventricular arrhythmias in another series. In most cases, bleeding was the main reason for reoperation [Dyszkiewicz 1998].

Lung cancer is considered one of the risk factors for onset of postoperative arrhythmias, not for the disease per se, but because a history of smoking and COPD often associated in these patients causes a decrease in cardiopulmonary function. Moreover, lung cancer requires a more extensive lung resection than a benign disease, and the incidence of arrhythmias is higher following pneumonectomy or lobectomy as compared with smaller resections [Ciriaco 2000].

In our study, no patient received prophylactic antiarrhythmic drugs. During the last years, some studies demonstrated the effectiveness of some prophylactic antiarrhythmic drugs in reducing the incidence of arrhythmias in patients known to be at increased risk for this complication after major thoracic operations [Lanza 2003; Amar 2000].

Treatment of postoperative supraventricular arrhythmias after lung resection is still a controversial topic. In some studies, once arrhythmias were diagnosed, immediate treatment was introduced [Ciriaco 2000, Tisdale 2009]; others documented that supraventricular arrhythmia after lung resection is usually considered a self-limited event [Anile 2012].

In our study, once supraventricular arrhythmia was diagnosed, immediate treatment was introduced. Firstly, special care was taken to maintain potassium levels above 4 mmol/L. Additionally, magnesium sulphate (2.0-4.0 g/day) was administered by continuous drip. During the periods of AF, all patients were fully anticoagulated with heparin infusion if the AF was recurrent or remained for more than 12 hours continuously. We were able to restore stable sinus rhythm using b-blockers for supraventricular tachycardia, and amiodarone for AF patients. We started with a loading infusion of 300 mg in 100 cc of 5% dextrose solution given over 30-40 minutes, followed by a 37.5 mg per hour intravenous infusion for 24 hours. All patients returned to sinus rhythm during this period. We then started the maintenance dose of oral amiodarone 200 mg three times daily for one week, followed by 200 mg twice daily for one week, then 200 mg once daily for one week, and finally 100 mg once daily for one month). There was no recurrence of AF during the period of follow-up.

CONCLUSIONS

(1) Postoperative supraventricular arrhythmias are a frequent and serious complication in elderly patients undergoing major thoracic operations; (2) Supraventricular arrhythmias are more frequent in patients with a history of prior heart disease. The selection criteria imposed by thoracic surgeons might prevent patients with clinically relevant cardiac disease from undergoing surgical intervention; (3) Lung resection is the main risk factor for postoperative supraventricular arrhythmia. Also, the greater the extent of pulmonary resection (pneumonectomy), the more significantly increased the prevalence of supraventricular arrhythmia; (4) Postoperative supraventricular arrhythmia is a treatable complication and does not affect postoperative morbidity and mortality significantly.

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