Perioperative cardiac arrhythmias in patients undergoing surgical treatment for lung cancer

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Abstract: Introduction. Thoracic surgery is associated with a high risk of morbidity and mortality. Cardiac arrhythmias are the most common and severe complications in early postoperative period. **Objectives.** Evaluation of the prevalence and causes of cardiac arrythmias, factors that predispose to their occurrence and their influence on general state of health in short-term postoperative period. **Patients and methods.** The study was performed in 80 patients with proven primary non-small cell lung cancer. We analyzed demographic data, type of carcinoma, presence of other diseases, laboratory results, and echocardiograms performed 2 times before and after operation and 24-hour Holter monitoring obtained 3 times – a day before thoracotomy and on the 1st and 5th postoperative day. **Results.** There were no significant changes in a total number of supraventricular ectopic beats during 3 consecutive 24-hour Holter recordings. The second Holter recording performed on the 1st postoperative day showed a statistically significant increase ($p < 0.05$) in the number of ventricular premature beats, which persisted on a similar, higher level on the 5th day. Twenty-four patients (30%) developed atrial fibrillation (AF) in the postoperative period. The average time of the duration of AF was 2.62 days with the peak incidence during 1st and 2nd day after operation (total 62.5%). Apart from cigarette smoking, no other epidemiological and clinical variables affected the occurrence of postoperative AF ($p > 0.05$). **Conclusions.** Paroxysmal atrial fibrillation is the most common type of arrhythmias in early postoperative period after thoracic surgery. Patients who underwent thoracic surgery should be under cardiological surveillance during the first postoperative days. Routine prevention with anticoagulants in patients after pulmonary tumor resection should be implemented based on their current clinical condition.

Key words: arrhythmia, atrial fibrillation, lung cancer, postoperative complications, thoracotomy

INTRODUCTION

Lung cancer has been an important and always growing medical and social problem for several dozens of years. Twenty thousand new incidents are found in Poland each year [1]. In the case of non-small cell lung cancer which constitutes 75–80% of all cases, the lung cancer tissue resection is the treatment of choice. Depending on the grade of advancement of cancer patients are qualified to lobectomy, bilobectomy or pulmonectomy.

Thoracic surgery procedures are among high complication risk procedures. Cardiac arrhythmias are one of the more important problems among them. Among paroxysmal supraventricular tachyarrythmias occurring after thoracic surgery procedures, atrial fibrillation (AF), supraventricular tachycardia (SVT), and supraventricular beat (SVB) are the most frequent ones [2-5]. According to some authors frequent supraventricular beat in the preoperative ECG may forerun AF paroxysms after surgery [6]. Ventricular ectopic beat (VEB), or non-sustained ventricular tachycardia (nVT) are less frequent ventricular cardiac arrhythmias [7].

Opinions on the importance of arrhythmias after thoracic surgery presented in available data are diverse. Some authors think that they are relatively mild complications, with a tendency to disappear spontaneously [5,8,9], however the majority consider postoperative cardiac arrhythmias as responsible for the worsening of the patient's general condition, the aggravation of hemodynamic disorders, the hospitalization time prolongation and the increase of early and even late mortality [2,3,10-13].

The aim of the study was a thorough analysis of cardiac arrhythmias occurrence in an attempt to describe the predisposing factors and determine the influence of cardiac arrhythmias on the lung cancer patient's postoperative course and early prognosis.

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PATIENTS AND METHODS

Eighty patients aged 39–83 were studied, 60 males (75%) and 20 females (25%) with diagnosed lung cancer, accepted for surgery. The patients were hospitalized during the years 2004–2005, in the Department of Thoracic Surgery of the Copernicus Regional Specialist Hospital in Łódź. Before surgery each patient was examined subjectively and objectively with the following parameters checked: age, sex, body mass, body height (body max index was derived), information concerning smoking (the number of pack years of smoking was derived), history for cardiovascular diseases including symptoms of angina pectoris, old myocardial infarction, arterial hypertension, diabetes and currently administered drugs was taken, as well as heart efficiency according to NYHA was determined.

Laboratory tests done in each patient were: total blood count, iongram, urea, creatinine, thyrotropic hormone level, and C-reactive protein, arterial blood gas analysis, and also the ECG registration, the 24-h ECG registration with the use of Holter recording method. Postoperatively, the patients underwent the same examination twice, on the 1st and the 5th days. The registration was done with the use of the 3-channel, Medilog MR 63 (of Oxford Polska Holding make) registration machine, with a magnetic tape registration. The registered data were analyzed with the use of the Oxford Polska Holding – Medilog Cardiologic System version 1.3. Minimal and maximal sinus rhythm rate, the presence and duration of paroxysmal cardiac arrhythmias (paroxysmal atrial fibrillation, paroxysmal atrial tachycardia), the minimal, maximal and average number of supraventriclar premature beats per hour, and the total number of supraventriclar premature beats per day, the minimal, maximal and average number of premature ventricular beats per hour, and the total number of premature ventricular beats per day.

The occurrence of atrial flutter and fibrillation was examined together in this study, which, concerning the discussed subject, is widely accepted in available data [5,9]. In patients with an AF episode occurring between Holter registrations, arrhythmia was diagnosed based on the ECG result. An AF of ≥15 minute duration was regarded to be clinically important [14].

In each patient a transthoracic echocardiography with a Doppler ultrasound registration presentation, using the General Electric Vivid 4 ultrasound machine with the use of a variable wave frequency sector probe 1.5–3.6 MHz (usually 1.7 MHz) with a harmonic amplification, was performed before the operation. The heart cavities diameters and the myocardium thickness in systole and diastole were obtained with the M-mode presentation. The left ventricle ejection fraction was obtained from the 4-chamber apical view by Simpson. The heart valves function was assessed with the use of the same method. The same method was employed to obtain the heart valves function. The pulmonary artery maximal systolic pressure was obtained by the continuous wave technique, employing the rule: pulmonary artery maximal systolic pressure = tricuspid valve maximal gradient + central venous pressure level. This examination was repeated on the 6th postoperative day. The repeated examination result could not be registered due to postoperative subcutaneous pneumothorax in 2 patients.

The routine ECG registration was performed daily, beginning with the 1st postoperative day in all patients until the discharge day. The rate and type of the leading rhythm were analyzed as well as the presence of cardiac arrhythmias and conduction disorders, left ventricle hypertrophy traits, myocardial ischemia traits and traits of old myocardial infarction.

During the first 24 postoperative hours patients were constantly monitored, in the ECG monitors equipped, postoperative room. Thoracic suction was applied in all patients. On the 1st day, 75 (93%) patients' clinical condition was good enough to move them to a general room.

Obtained data were statistically analyzed. A significance level of $\alpha = 0.05$ was adopted for all statistical tests applied. The statistical analysis was performed with the use of the SPSS PC and STATISTICA programs.

The study was performed having obtained the consent of the Łódź Medical University Bioethical Committee (No. 134/04).

RESULTS

The characteristics of patients are shown in Table 1.

The leading rhythm in the initial standard ECG registration in all patients was sinus rhythm with no important, accompanying cardiac arrhythmias. During the preoperative period adrenergic blocking agents were administered in 5 patients. This treatment was being continued throughout the whole hospitalization period. During the first ECG registration with the use of Holter monitoring, no complex or dangerous arrhythmia was found in any patient. In 26 individuals (32.5%) SVT short duration episodes, of 40 seconds' maximal duration, occurred. In 12 individuals (15%) initially, no ventricular arrhythmia was found. In 6 individuals (7.5%), a total amount of 11 nVT episodes of 6.6 seconds' maximal duration were found.

In the group of 80 patients who underwent pulmonary resection 16 pulmonectomies (6 right and 10 left) and 64 lobectomies (42 right and 22 left) were performed.

The prevalence and character of cardiac arrhythmias in the postoperative period, found with the daily ECG registration and Holter monitoring performed twice, were analyzed. No important change in the total number of SVB in the 3 consecutive 24 h ECG registrations (statistically non-significant – NS) was found. In the 2nd Holter registration, a statistically significant total daily ($p < 0.05$) VEB amount rise, which persisted at the same higher level on the 5th postoperative day (Tab. 2), was found. No statistically significant difference in the SVT and nVT episode prevalence in the consecutive Holter registrations was found. No episodes of sustained tachycardia

(>30 s) were found in any of the performed Holter registrations.

A new type of arrhythmia, which occurred postoperatively, was AF.

The number of patients in whom AF paroxysms in the consecutive Holter registrations were found, as well as the total number of patients in whom AF was found with continuous monitoring and the routine ECG, during hospitalization, is shown in Table 3.

The average AF duration was 2.62 days. The most, new AF incidents were found on the 1st and the 2nd day (totally 62.49%). Figure 1 shows the number of patients, in whom a new AF paroxysm occurred in the consecutive postoperative days. In the group of 16 patients, who underwent pulmonectomy, AF occurred in 6 individuals (37.5%); however in 64 patients, who underwent lobectomy, AF occurred in 18 individuals (28.12%). Atrial fibrillation occurred in 5 of 10 individuals (50%), who underwent left pulmonectomy, and only in 1 of 6 individuals (16.66%) who underwent right pulmonectomy. The differences did not reach a statistical significance. No statistically significant AF occurrence risk, depending on the localization, extensiveness and side of performed operation, was found. The average patient age, in which an atrial fibrillation paroxysm occurred, was 60.4 years (±7.9), and the average patient age with no AF – 62.2 years (±9.3). The difference found was not statistically significant.

All the studied independent variables, potentially related to AF (dependent variable), were included in the single-factor logistic regression (Fig. 2) analysis in order to determine the risk factors of AF occurrence after pulmonary resection.

It has been demonstrated that only the number of pack years of smoking per year was importantly related ($p < 0.05$) to AF occurrence. Every 10 successive pack years of smoking per year augmented AF occurrence risk factor by over 40%. The rest of the studied epidemiologic and clinical parameters, including age, sex, ischemic heart disease or heart insufficiency grade did not alter the probability of AF ($p > 0.05$) paroxysm occurrence. The postoperative VEB incidence augmentation was not importantly related to any of the parameters analyzed. The analysis of the risk factors directly related to the operation performed, including the operation duration, intraoperative cardiac arrhythmias, amount of blood loss and general anesthesia administration of atropine, did not reveal an influence on the prevalence, or the increase of postoperative arrythmias.

Initial and postoperative echocardiography results were compared in patients and a rise in the number of tricuspid valve insufficiency – IT was found, with no statistically significant difference in the tricuspid regurgitation intensification (Tab. 4). No statistically significant alteration in right ventricle dimensions, or the derived pulmonary artery maximal systolic pressure, was however found. No relation between the presence and the severity of IT, and the AF paroxysms occurrence (Tab. 5) was found.

When analyzing the influence of AF paroxysm, on the hospitalization period postoperatively, it was found that patients with this type of cardiac arrhythmias were on average hospitalized 2 days longer.

Table 1. Patient characteristics in preoperative period

Patient characteristics	Patient number (%) n = 80
age (years)	61.6 ±8.9
males	60 (75)
BMI (kg/m^2)	25.9 ±4.95
cigarette smoking	71 (88.75)
number of pack years	44.6 ±25.8
preoperative diagnosis	
planocellular cancer	44 (55)
adenocarcinoma	31 (38.75)
large cell lung cancer	3 (3.75)
carcinoid	2 (2.5)
associated diseases	
ischemic heart disease	22 (27.5)
old myocardial infarction	5 (6.25)
arterial hypertension	31 (38.75)
diabetes	9 (11.3)
insulin therapy	1 (1.25)

The data are shown as mean ±standard deviation or number (percent). BMI – body mass index

In the group of 80 operated patients, 3 deaths occurred (general mortality 3.75%). The pulmonectomy group mortality was 1/16, that is 6.25%, and the lobectomy group – 2/64, that is 3.12%. The difference found, was not statistically significant. Cardiac arrhythmia or cerebral stroke werenot the initial reasons for death in any case. One patient died from a pleural bleeding which required rethoracotomy, another patient from pneumonia with severe respiratory failure, the third reason for death was acute pancreatitis.

DISSCUSSION

The role of postoperative AF lies not only in the direct adverse hemodynamic implications, but also in the increase of thrombi complication threat, of which cancer patients are at a high risk [15,16]. Postoperatively, in authors' own studies, one or more AF episodes have been noted in 24 individuals (30%). A relatively high percent of discovered AF episodes may be related to the employed method of thedouble 24 h postoperative ECG monitoring. In the majority of studies, cardiac arrhythmias were diagnosed, based on the routine ECG registration performed daily or in the case of reported, often nonspecific, complaints [2,4,15].

Table 2. The number of ventricular ectopic beats (VEB) – a comparison of Holter monitoring from the 3 consecutive ECG registrations and comparison of differences between individual measurements significance degree

	Holter 1	Holter 2	Holter 3	p		
	median	median	median	1. vs. 2. measurement	2. vs. 3. measurement	1. vs. 3. measurement
VEB/d	8.0	26.5	42.0	0.028	0.494	0.013
VEB mean/h	0.3	1.1	1.5	0.028	0.598	0.012
VEB max/h	3.0	7.0	8.0	0.022	0.214	0.011

Table 3. The incidence of atrial fibrillation paroxysms (AF) in the following ECG registrations using the Holter method and in the routine ECG (together)

	Holter 1		Holter 2		Holter 3		Totally	
	n	%	n	%	n	%	n	%
without AF	80	100	65	81.25	64	81.02	56	70
AF	0	0	15	18.75	15	18.98	24	30

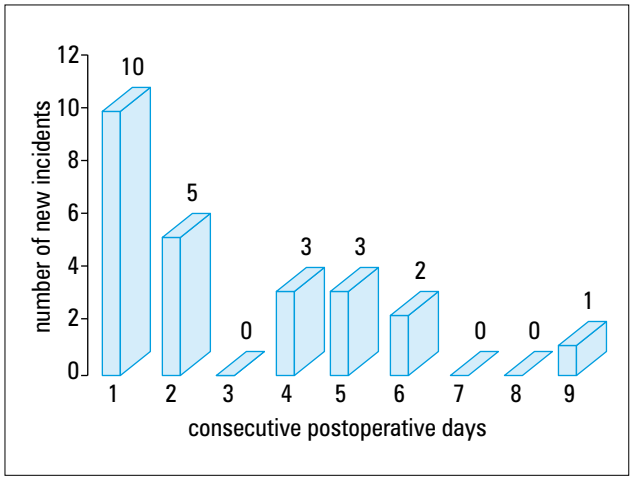

Fig. 1. Number of patients, with new atrial fibrillation paroxysm (AF) occurrence in consecutive postoperative days

It is stressed in available data, that a total pulmonary resection increases the risk for cardiac arrhythmias and postoperative mortality occurrence, in comparison with less extensive operations. It is generally accepted that, the post lobectomy AF incidence is about 10–20%, and the post pulmonectomy AF incidence increases on the average twice [2,4,17]. A greater post pulmonectomy than post lobectomy AF occurrence (37.5% vs. 28.12%) was also observed in authors' own studies, the difference however did not reach a statistical significance. Differently to the majority of reports [5,12,17,18], in authors' own studies atrial fibrillation occurred in a greater percent with the left (50%) than with the right (16.66%) (NS) pulmonectomy. Though it is not an isolated result [19].

The postoperative cardiac arrhythmias occurrence mechanism, including fast supraventricular rythms, has not been finally determined yet. The influence of an excessive right atrium and right ventricle pressure load, the increase of intramural tension as well as exceeding the right ventricle compensation mechanisms capability resulting from the increase in pulmonary vascular resistance [2,4,20], are being considered. The influence of surgical intervention at the area of the pulmonary vein outlet especially including the upper veins is also being considered. Mechanical manipulations resulting in local tissue damage and the subsequent initiation of repair mechanisms can initiate the occurrence of premature beats triggering AF paroxysms [21,22].

Rena et al. [22] think that a greater incidence of AF paroxysms post pulmonectomy is mainly the result of the pulmonary jilus structure disturbance, and not of the respiratory surface limitation.

The patient's age is seen as the most important postoperative arrhythmias risk factor especially of AF [8,13,18]. The ageing process mechanism, which is related to the worsening of intracellular connections as a result of fibrination, and the myocardial cells apoptosis phenomenon may be the pathophysiological fundament for this relation. The slowed and heterogenic conduction in atrial myocardium is the reason for microreentry substrate formation, responsible for AF. [23]. However, many authors did not find a relation between the age and cardiac arrhythmia occurrence [5,19,24]. In authors' own studies, age did not occur to be an AF incidence determining factor.

The paroxysms of rapid supraventricular rhythms occur most often during the first 3 postoperative days. The incidents of first-time cardiac arrhythmias are less and less frequent with time lapse from the operation. Ciriaco et al. [25] think that heart rhythm estimation based on the standard ECG in all patients directly before discharge from hospital is recommended, as an AF paroxysm may occur even several days postopera-

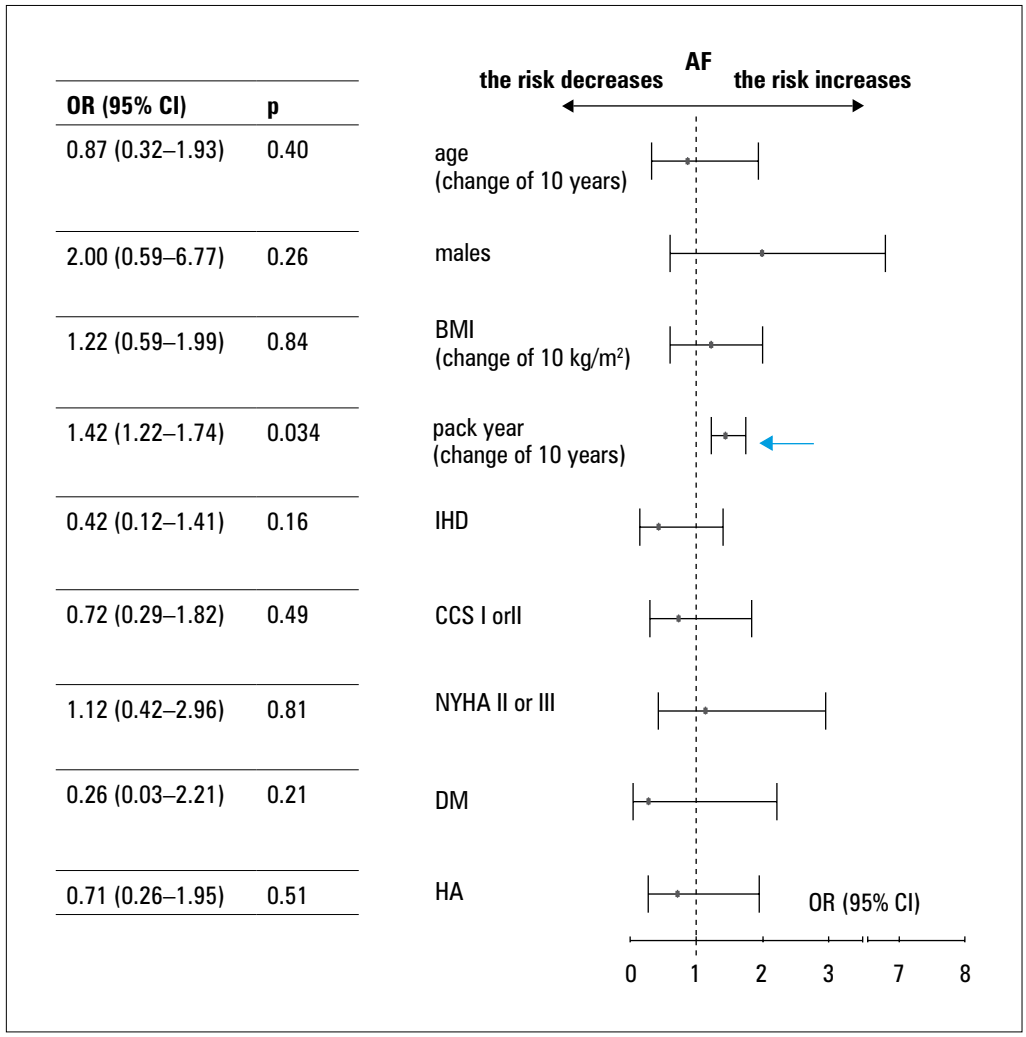

Fig. 2. Relation of analyzed independent variables and AF occurrence in the single-factor logistic regression model. An arrow shows the only factor influencing the risk for AF occurrence. The data are shown as odds ratio (OR; 95% Confidence interval [CI]). Abbreviations: AF – atrial fibrillation, BMI – body mass index, DM – diabetes mellitus, HA – arterial hypertension, IHD – ischemic heart disease

tively and it is often clinically low symptomatic. In authors' own studies on the 1st postoperative day AF paroxysms made 41.66% of all AF episodes, and together with the 2nd day 62.49% new AF incidents were registered during that period.

In authors' own studies an important relation was only shown between the number of pack years of smoking and AF occurrence. Evidence of a similar relation can not be found in available data, though, it is accepted that smoking, especially >20 pack years of smoking, definitely increases the risk for pulmonary postoperative complications, especially the incidence of postoperative pneumonia [26].

Due to thrombotic complications risk, in postoperative patients with paroxysmal AF and in patients not treated surgically, the administration of anticoagulants is advisable [27]. Anticoagulation diminishes the risk for thrombi formation in the systemic circulation, but at the same time it increases the risk for hemorrhagic complications. In the early postoperative period, low molecular weight heparin (LMWH) is used most frequently. In the author's own study all patients routinely received LMWH in prophylactic doses. In the event of AF occurrence, the dose was augmented to therapeutic levels.

Table 4. Incidence and intensity rate of tricuspid valve insufficiency (IT) preoperatively and on the 6th postoperative day

	Before operation		After operation		p
	n	%	n	%	
IT not present	50	62.5	37	48.1	0.076
IT I	27	33.8	31	40.3	
IT II or III	3	3.8	9	11.7	

In summary, the dominating type of cardiac arrhythmia in early postoperative thoracic surgery patients is paroxysmal atrial fibrillation. In early postoperative days patients should undergo a regular cardiologic monitoring, and the routine anticoagulant prophylaxis should take into account the patients' current clinical condition. Preoperative smoking significantly increases the statistical risk for tachyarrhythmia occurrence

Table 5. Relation between the presence and intensity rate of tricuspid insufficiency (IT) found on the 6th postoperative day and atrial fibrillation occurrence

	OR	95% CI		p
IT not present	1			
IT I	0.82	0.28	2.40	0.7
IT II or III	1.89	0.43	8.41	0.4
IT present	1.01	0.38	2.69	0.9

OR – odds ratio, 95% CI – 95% confidence interval

(each 10 following pack years of smoking increased AF postoperative incidence risk by over 40%).

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