

Department of Cardiac Surgery, Medical University of Lublin
Department of Thoracic Surgery, Medical University of Lublin

JANUSZ STAŻKA

*Diagnostic value of electrocardiographic investigations in preoperative
evaluation of patients with lung cancer*

Three avenues of thought have evolved if we plan lung tissue resection. The first premise, based on early studies of spirometry and "split-function" spirometry, suggests that eliminating the patients with severe ventilatory compromise should permit a higher rate of survival (1). The second concept proposes that postoperative pulmonary hypertension and *cor pulmonale* must be predicted even if invasive studies are required. The third and newest precept is that survivable noncrippling postoperative morbidity as well as mortality should be predicted before surgery (4).

The purpose of the study was to evaluate the diagnostic value of electrocardiographic investigation for patients with lung cancer considered to be candidates for lung tissue resection.

MATERIAL AND METHODS

The study population consisted of 50 male patients 21 – 72 years old (average: 55.8) with lung cancer who were candidates for lung tissue resection (8, 9).

All the patients underwent routine 12-lead electrocardiogram (I, II, III, V_R, V_L, V_F, V₁₋₆) registered using three-channel recorder Multicard E-30. Electrocardiographic curve was evaluated exact to 0.5 mm counting the mean value of three consecutive heart evolutions.

There were observed electrocardiographic traits of right ventricular hypertrophy Hawryłkiewicz (3) – Table 1. The presence of the traits 1, 2, 6, 8, 9, 12 was recognized as significant for right ventricular hypertrophy, the other ones regarded as less important.

Table 1. The traits recognized as significant for right ventricular hypertrophy (30)

1	$P > 0.25$ mV in II, III and V_F
2	QRS in frontal plane $+ 95^\circ$
3	$R > Q$ or $R > S$ in V_R
4	$R > 0.3$ mV in V_R
5	$R > S$ in V_1
6	$R > 0.7$ mV in V_1
7	inversion of R wave delay > 35 msec in V_1
8	dextrogyria
9	sum R wave in V_1 and S wave in $V_5 > 1.05$ mV
10	T wave inversion in $V_1 - V_3$
11	ST decrease in II, III, V_F
12	incomplete or complete block of right bundle brunch
13	volvulus of S wave or QS complex in V_1

All patients underwent standard pulmonary function testing including vital capacity (VC) and one-second forced expiratory volume (FEV_1).

The hemodynamic studies were performed in laboratory at the temperature of $18 - 22^\circ$ C. The brachial artery was punctured to measure intra-arterial pressure (BAP) and to sample arterial blood. A venous floating catheter (Swan-Ganz Monitoring Thermodilution Catheter Model 93-115-7F) was introduced in local anesthesia in the left antecubital or external jugular vein and positioned in the pulmonary artery to sample mixed venous blood. The Swan-Ganz catheter was positioned so that mean central venous pressure (CVP), mean pulmonary wedge pressure (PCWP) as well as mean pulmonary artery pressure (PAP) were measured. A Statham P 23SD strain gauge coupled to Simonsen and Weel system 8000 amplifier was used for the pressure monitored. Systemic vascular resistance (SVR), pulmonary vascular resistance (PVR) and cardiac index (CI) were calculated using Erich Jäger Erooxyscreen hemodynamic computer.

Blood gas analysis was done for oxygen, carbon dioxide, oxygen saturation and pH in arterial (PaO_2 , $PaCO_2$, SaO_2 , pH) and mixed venous blood (PvO_2 , $PvCO_2$, SvO_2 , pH) using Corning 168 pH.

Hemodynamic and gasometric measurements were done at rest ("r") and after exercise ("e") on cycle ergometer (Medicor type KE 11) in supine position for 5 minutes with 50 W workload.

The results were subject to statistical analysis using IMP 85 computer (6).

RESULTS

27 patients (A) had no electrocardiographic traits of right ventricular hypertrophy and 5 patients (B) had a single trait. 18 patients (C) had evident electrocardiographic traits of right ventricular hypertrophy. The average values of age, spiographic and mean pulmo-

Table 2. The average values of age, spiographic parameters and mean pulmonary artery pressures at rest (PAP^r) and after exercise (PAP^e) (mmHg)

Group	No. of pts.	Age	VC %	FEV ₁ %	PAP ^r	PAP ^e
A	27	55	105 %	67 %	18.2 mmHg	30.9 mmHg
B	5	51.8	89.3 %	65 %	24.2 mmHg	34.8 mmHg
C	18	60.4	67.6 %	52.8 %	20.9 mmHg	36.3 mmHg

nary artery pressure at rest and after exercise in those 3 groups are shown in Table 2. Among 18 patients with electrocardiographic traits of right ventricular hypertrophy 11 (61.1%) had increased mean pulmonary artery pressure at rest and after exercise, and 6 patients (33.3%) had increased only mean pulmonary artery pressure after exercise. Only 1 patient (5.6%) had normal pulmonary artery pressure at rest and after exercise.

On the basis of the measurements the Spearman correlation coefficient and "r" correlation coefficient between electrographic traits of right ventricular hypertrophy and spiographic, gasometric and hemodynamic parameters were calculated.

There were no correlations between electrocardiographic picture and VC%, some gasometric (pH, PvO₂, SvO₂, PaO₂^e) and most hemodynamic (RR, PPCWP, CI, SVR, PVR, LVSWI, RVSWI, CVP^e) parameters. Statistical significance correlations between electrocardiographic traits of right ventricular hypertrophy are shown in Table 3.

Table 3. Correlation between electrocardiographic traits of right ventricular hypertrophy and gasometric and hemodynamic parameters

	Spearman correlation coefficient	Statistical significance
FEV ₁ %	r = - 0.302	p > 0.05
PaO ₂ ^r	r = - 0.329	p > 0.05
PaCO ₂ ^r	r = 0.3	p > 0.05
SaO ₂ ^r	r = - 0.252	p > 0.05
PvCO ₂ ^r	r = 0.385	p > 0.01
PaCO ₂ ^e	r = 0.37	p > 0.01
PvCO ₂ ^e	r = 0.424	p > 0.01
CVP ^r	r = 0.288	p > 0.05
PAP ^r	r = 0.282	p > 0.05
PAP ^e	r = 0.305	p > 0.05

DISCUSSION

In view of dismal prognosis of unresected bronchial cancer, surgical resection should be encouraged even in patients with borderline cardiopulmonary function. Accurate estimation of the cardiopulmonary reserve is therefore desirable to avoid denying potentially curative treatment on the one hand and severe postoperative disability on the other.

Various parameters (lung volumes, gas exchange, pulmonary hemodynamics, exercise endurance) are reviewed concerning their predictive values to evaluate functional operability (7).

The value of electrocardiographic tests in diagnosis of pulmonary artery pressure in chronic lung diseases and in mitral stenosis is the subject of a public debate. Relevant articles discuss the value of individual ECG features which testify to the hypertrophy of the right ventricle of the heart in diagnosing pulmonary hypertension. It is now commonly assumed that the heart axis deviation and the occurrence of the QRS complex above the right ventricle are of major importance.

The value of P wave in evaluating the degree of pulmonary hypertension is a debatable issue. Studies conducted by Hawryłkiewicz and Pasyk (3, 5) did not indicate a uniform nature of the P wave in patients diagnosed for pulmonary hypertension. It follows from the studies that the correlation between these indicators has not been determined. It appears that with the rise of pulmonary hypertension the number of positive ECG features increases (5). It must be borne in mind, however, that the ECG picture can disclose significant differences in patients diagnosed for hypertension as well as in persons after workload who do not suffer from any tension disorders. Conversely, not every case of pulmonary hypertension is reflected in the ECG picture.

There is surprisingly little information about the effects of lung volume on the resting ECG in normal subjects. Einthoven et al. first described changes during ventilation in the frontal plane axis and alterations in R, S and P wave voltage of those complexes are only a few pieces of information about the effects of lung volume (1).

In this study there was found the correlation between electrocardiographic investigations and one-second forced expiratory volume. There were found no correlations between ECG and vital capacity. Electrocardiographic changes in pulmonary disease such as bronchitis or pulmonary emphysema can be explained by the hypertrophy or broadening of the right ventricle and the right atrium of the heart, a drop in electric conduction caused by emphysematous lungs and a distorted position of the heart. The heart assumes a vertical position with its tip somewhat twisted towards the back due to the level of diaphragm and increase in the tidal volume.

In this study 23 patients of 50 (46%) had electrocardiographic traits of right ventricular hypertrophy and only one of them had normal pulmonary artery pressure. It means that electrocardiographic investigations have a great value in predicting pulmonary hypertension in patients before lung tissue.

CONCLUSIONS

Most of the patients qualified for lung tissue resection have abnormal electrocardiographic curve as well as pulmonary artery hypertension. Statistical analysis revealed statistical significance correlations between ECG

and pulmonary artery hypertension as well as one-second forced expiratory volume. It means that electrocardiographic trials of right ventricle hypertrophy help predict pulmonary hypertension.

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SUMMARY

The pulmonary hypertension and *cor pulmonale* in patients before lung tissue resection must be predicted even if invasive studies are required. The purpose of the study was to evaluate the diagnostic value of electrocardiographic investigation for patients with lung cancer, considered to be candidates for lung tissue resection. The study comprised 50 male patients with bronchial carcinoma before lung tissue resection. All of them had gasometric, and hemodynamic parameters of pulmonary circulation assessed at rest and after exercise. The ECG and spirographic investigations were done in all patients. It was found that 23 of 50 patients had electrocardiographic traits of right ventricle hypertrophy and only one of them had normal pulmonary circulation parameters. There were also found correlations between ECG curve and FEV_1 %, most of gasometric and some of pulmonary hemodynamic parameters.

Wartość diagnostyczna badania elektrokardiograficznego w przedoperacyjnej ocenie pacjentów z rakiem płuca

Badanie elektrokardiograficzne jest jednym z badań wykonywanych rutynowo u pacjentów z chorobami płuc, a szczególnie kwalifikowanych do leczenia operacyjnego. Właściwa ocena przedoperacyjna wydolności układów oddechowego i krążenia zmniejsza ryzyko powikłań i zgonu pacjentów po zabiegu resekcji mięszu płucnego, co jest szczególnie istotne w zabiegach operacyjnych pacjentów z rakiem oskrzela.

Celem badania było określenie wartości badania elektrokardiograficznego w ocenie wydolności krążenia płucnego u pacjentów z rakiem płuca, kwalifikowanych do resekcji mięszu płucnego. Badaniami objęto 50 mężczyzn z rozpoznanym rakiem płuca. U wszystkich pacjentów oceniano parametry spirograficzne, hemodynamiczne, gazometryczne, starając się znaleźć współzależności z obrazem krzywej elektrokardiograficznej.

Spośród 50 badanych pacjentów u 23 stwierdzono elektrokardiograficzne cechy przerostu prawego serca, przy czym tylko jeden z nich nie wykazywał nadciśnienia płucnego.

Otrzymane wyniki poddano analizie statystycznej, stwierdzając korelacje między wielkością parametrów gazometrycznych, średnim ciśnieniem w tętnicy płucnej oraz FEV_1 %.