THE ROLE OF IMAGING IN PULMONARY EMBOLISM OUTCOME

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Abstract: *Pulmonary embolism (PE) is a pathology with still high mortality. Of the factors that influence natural evolution of PE, the most important is the degree of obstruction, hemodynamic status, the cardiopulmonar pre-existing status, length of thrombosis and spontaneous thrombolytic therapy of lungs vascular endothelium. The reason for classifying the patients on the basis of risk is to identify those who, although they present submassive PE could benefit from thrombolytic therapy. In our study, we examined whether changes in ECG, echocardiography and CT, objectivised through ECGScore and CTScore, could be useful in risk stratification in patients diagnosed with PE. Conclusion: There was no significant statistically association between ECGScore, CTScore and mortality at 30 days or 1 year. There is a certain association of these scores with immediate mortality (first 24 hours).*

Cuvinte cheie: *trombembolism pulmonar, prognostic, investigații imagistice*

Rezumat: *TEP este o patologie cu mortalitate încă crescută. Dintre factorii care influenţează cel mai mult evoluția naturală a TEP, cel mai important îl constituie gradul de obstrucţie, ulterior vin statusul hemodinamic, statusul cardiopulmonar preexistent, vechimea trombozei și gradul de tromboliză spontană a endoteliului pulmonar. Motivul efectuării unor stratificări a pacienților pe baza riscului îl reprezintă identificarea acelora care, deși se prezintă cu TEP submasiv ar putea beneficia de terapia trombolitică. În studiul nostru, am analizat dacă modificările ECG, modificările ecocardiografice, și gradul de obstrucție pulmonară, obiectivate prin ECGScore și CTScore, ar putea fi utili în stratificarea riscului la pacienții diagnosticați cu TEP. Concluzie: Nu s-a demonstrat nici o asociere semnificativă din punct de vedere statistic între ECGScore, CTScore și mortalitatea la 30 zile sau la 1 an. Există însă un grad de asociere a acestor scoruri cu mortalitatea imediată(primele 24 ore).*

INTRODUCTION

The progress made in recent years in terms of managing patients with suspicion of PE improved the accuracy in identifying this disease and made the diagnosis algorithms to be safer and easier to use in daily practice. In spite of these, PE is maintained among the disorders with increased morbidity and mortality. Mortality at one month is of 8% in treated patients and of 30% in the case of untreated ones, the evolution of PE greatly depending on the time period in which the diagnosis is established and therapeutic attitude is adopted.

Of the factors that influence the most natural evolution of PE, the most important are the degree of obstruction, hemodynamic status, cardiopulmonar pre-existing status, length of thrombosis spontaneous thrombolitic therapy of lungs vascular endothelium.(1)

Introduction of MDCT modified substantially the addressing of acute PE, and the accuracy of diagnoses has increased in parallel with improved imaging techniques. In everyday practice, angioCT has become first-line investigation performed in patients with suspicion of PE. Moreover, studies conducted on small populational groups suggests that the CT-scan contributes to risk stratification of patients with confirmed diagnosis of PE.(2) Heart examination in 4 chamber position, can detect the increase of RV. It has been shown an increase in the 30-day mortality in patients with increased RV size (4-room reconstruction), defined as VD/VS > 0.9, compared to those without this finding.(3,4)

Transthoracic echocardiography, although there is a simple method of investigation, at hand and without risk, her role in the diagnosis of PE is limited due to its low sensitivity and specificity. In patients with PE, hemodynamically stable, echocardiography is a useful instrument for establish the risk classes. A series of registers and cohort studies have demonstrated an association between different echocardiographic parameters: RV dilatation (right ventricle> left ventricle diameter or RV end diastolic diameter > 30 mm), hipokinezia of RV wall, paradoxical movement of IVS, pulmonary hypertension (the difference between the right ventricle and right atrium pressure > 30 mmHg or pulmonary acceleration time < 80ms), and intraspital mortality and morbidity.(6-9,10-12) In addition to dysfunction of RV, echocardiography may also identify specific markers, each indicating a doubling of risk of mortality in the PE: right-left shunt through a patent ovale foramen and the presence of thrombi in the right heart.(13,14)

Despite low sensibility and specificity of the symptoms and of the limited individual signs, the prognostic models make possible PE patients' classification in risk categories. Risk stratification of the PE is fundamentally not only to select an appropriate treatment strategy, but also to reduce the cost of management. Geneva prognostic index and Pulmonary Embolism Severity Index (PESI) are two standardized prognostic scores, which among the other clinic parameters have include the systolic arterial tension, to predict the likelihood of negative outcome. These scores have been

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validated to identify patients with low risk, who can opt for ambulatory treatment.(15)

ECG changes vary from normal to the complete pathological. Sinus tachycardia may be the only change present[5] or we may encounter: QRS axis deviated to the right, complete or incomplete right bundle branch block, where T negative waves in V1-V3 leads, enlarge P wave. Negativation of T wave in precordial leads is the most common and most solid sign of massive PE with very good sensitivity (85%) and specificity (95%), in addition, being an supplementary criterion of severity.(16-18) Qr in V1 appearance is due to excessive dilation of the right heart and correlates with the presence of RV dysfunction and with an unfavourable evolution.

Despite marked improvement of diagnosis and treatment of PE, it remains fully misunderstood; evolution and prognostic data, and here we talk about mortality and recurrence varies from one trial to another, without consensus.

PURPOSE

The study aimed to analyze the main changes in paraclinical and imaging examinations and evaluation of their relationship with the immediate, at 30 days and 1 year outcome.

METHODS

In the study, 330 patients were included who had been diagnosed on the basis AngioCT in Centre Hospitaliere Universitaire Liege, with PE. Patients included in the study were evaluated with ECG, echocardiographic and AngioCT examination. PESI prediction score was calculated, and on this basis, patients were classified into 5 mortality risk classes. Method of Scoring Pesi is told below. Statistical analysis was performed using Microsoft Excel software, Microsoft Office 2010 and SPSSv.22. It was aimed to assess some parameters, ECG and obstructive lung disease indices based on CT scan and integration into laboratory prognostic scores. These scores we named ECGScore and CTScore and their definition will be presented bewlow. Mathematical calculation is done by summing the scores obtained for each parameter included.

Table no. 1. Parameters scores included in ECG Score

AV> 100/'	2p
BRD minor	2p
BRD major	3p
T negative V1-V4	4p
Qr in V1	1p
S1Q3T3	2p
QRS right deviation	1p
None of above	1p
max	13p

Risk class on ECGScore: low, <2 points; intermediate, 2-5 points; high, 6-13 points

Table no. 2. CTS core

Bifurcation	22p
AP right	12p
A. Right upper lobar	5p
A. apical segmental	1p
A. Upward anterior segmentation	1p
A. Downward anterior segmentation	1p
A. Upward anterior segmentation	1p
A. Downward anterior segmentation	1p
A. Middle lobar	2p
A. lateral segmentation	1p
A. median segmentation	1p
A. Right lower lobar	5p
A. upper segmentation	1p
A. medial basal segmentation	1p
A. anterior basal segmentation	1p
A. lateral basal segmentation	1p
A. posterior basal segmentation	1p
AP left	10p
A. left upper lobar	5p
A. apical segmentation	1p
A. posterior segmentation	1p
A. Upward anterior segmentation	1p
A. Downtrend anterior segmentation	1p
A. Lingular	1p
A. left lower lobar	5p
A. upper segmentation	1p
A. medial basal segmentation	1p
A. anterior basal segmentation	1p
A. lateral basal segmentation	1p
A. posterior basal segmentation	1p
MAX	88p

Risk class on CTScore: low, <22 points; Intermediate, 22-43points; high, 44-88 points.

Table no. 3. ***Pulmonary Embolism Severity Index:***

Variable	Points
Age	**1point/year**
Male gender	**10**
Cancer	**30**
Congestive heart failure	**10**
Chronic lung disease	**10**
Heart rate > 110/min	**20**
Systolic blood pressure <	**30**
Respiratory rate ≥ 30/min	**20**
Body temperature < 36°	**20**
Disorientation, lethargy, stupor	**60**
Oxygen saturation <	**20**

Table no. 4. Mortality risk at 30 days according to the risk class

Risk category	Points	30-day mortality risk
Class I	**< 65**	**0-1,6 %**
Class II	**66 to 85**	**1.7-3,5 %**
Class III	**86 to 105**	**3.2-7,1 %**
Class IV	**106 to 125**	**4-11,4%**
Class V	**> 125**	**10-24.4 %**

RESULTS

The study includes 178 (53.9 %) women and 152 men (46.1%) aged between 18 and 96 years old, with an average of 66.64 ± 16.2 years old.

1. *Assessment of echocardiographic parameters*

Of the 330 patients included in the study were evaluated by echocardiographic examination 224. We want to highlight the main signs of right heart overload, namely the presence of a-/hipo-kinetic RV, paradoxical movement of the IVS, the presence of tricuspid regurgitation, assessment of RV / LV > 0.9, presence of thrombus in the RA . The ventricular wall motion disorders were found in 7 % of patients (23 of the patients) and paradoxical movement of the IVS was seen in 11.5 % of cases. View thrombus in the right heart was made in 7 cases (2.1%). Quantifying the degree of tricuspid regurgitation in patients in the study illustrated that most had a minimum degree of tricuspid regurgitation (38.5 %), 20.3% moderate and 30% severe. A total of 12 (3.6%) patients were diagnosed as not having tricuspid insufficiency. Of those who died within 24 hours , one patient (0.3 %) had right ventricular akinesia, and one patient also had paradoxical motion of IVS, to none of subjects view pictures of thrombus , and the ratio VD / VS > 1 was noted in one case . Also, one patient had minor tricupid regurgitation. Statistical analysis showed a minimum correlation between the presence of RV akinesia and mortality in the first 24 hours, with a Pearson correlation coefficient $r = 0.126$ and statistical value of *0.049*. No patient from falling within the 30-day mortality did not show kinetic RV disorders; paradoxical movement of the IVS was noted in 0.6 % of cases, tricuspid regurgitation in 3.3% (minimum 3% , moderate 2. 1% severe 0.9 %); a percentage of 0.6 % were RV / LV > 0.9 and one patient had the AD thrombosis. In the group of patients who died within 1 year, echocardiographic parameters analyzed were highlighted as follows: akinesia VD, paradoxical motion SIV- 0.9%, 6.9 % of the tricuspid regurgitation , RV / LV > 0, 9 to 0.6 % of cases, and no patient had thrombus in the right cavities . None of the echocardiographic parameters so it was described as prognostic factor for 30 days, or 1 year mortality.

2. Assessment of the severity score PESI

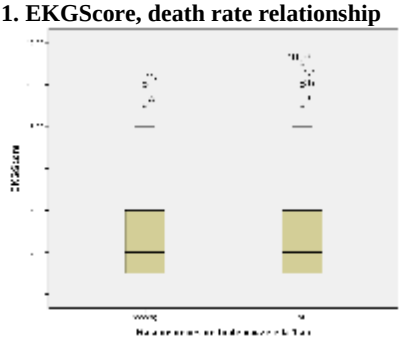
Beyond the PESI prognostic assessment score (which was calculated from 285 of the subjects) patients were included in the five risk classes as follows: Class I (1<=65 points) – 12,1%, class II (66-85 points)- 14,5%, class III(86-105 points)- 21,2%,class IV(106-125 points)- 18,5%. Class V(>125points)- 20%. Statistical analysis showed that PESI score correlates with mortality at 30 days. Nonparametric Mann -Whitney test shows a value of the test Z = -3.962 with a strong statistical significance, $p< 0.001$. Similarly, it is shown that PESI score correlates with mortality at 1 year, with a value of $Z = -4.325$ and $p<0,001$.

3. Assesement of ECGScore

ECG examination was performed on a total of 263 patients. Each of the patients was monitored presence of tachycardia, BRD major or minor, negative T waves in leads V1-V4, Qr in V1 and S1Q3T3 issues, and right QRS axis deviation. Depending on the presence of these parameters, ECG score was calculated (calculation method was described in Materials and methods), and patients were classified into risk classes, as follows: low risk class were integrated 90 patients (34, 2%) in the intermediate 135 (51.3%) and in the high 38 (14.4%). The value of the test varied from 1 to 11 points, with a mean of 2.82 and standard deviation of 2.27. The average score in the group of patients alive at 1 year was 2.83 ± 2.24, and is not found significant difference with that of the deceased, 2.78 ± 2.39 ($p = 0.566$) (figure no. 1).

$\chi 2$ test revealed a correlation between the ECG score and mortality at 24 hours, p = 0.05. The same statistical test showed that ECGScore is not a predictor for mortality at 30 days, and not even for a 1 year mortality.

Figure no. 1. EKGScore, death rate relationship



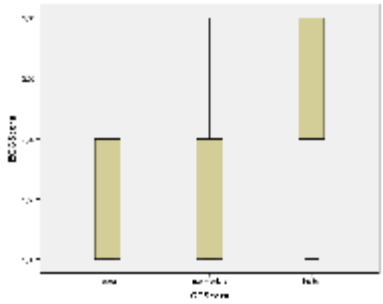
4. Assesement of CTScore

According to the CTScore results (calculation method described in materials and methods), patients were classified into three risk classes as follows: low-risk class 69, 7%, intermediate-25, 2% high -5.2%. Media CTScore was 12.46 ± 11.29; There were no statistically significant differences found between the mean score for those who survived to 1 year and those who died, 11.3 ± 11.3 versus 12.82 ± 11.27 (nonparametric Wilcoxon test value *1.42*, $p = 0.127$) (figure no. 2).

Figure no. 2. CTScore, death rate relationship

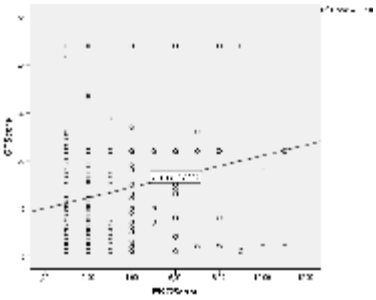
Both patients died within the first 24 hours were in the highest risk class; based on statistical analysis, we can say that CTScore is a prognostic factor for immediate mortality (with a $\chi 2$ test value of *37*.04 and $p < 0.001$). There was no statistical significance correlation between CTScore and mortality at 30 days or 1 year ($p = 0.54$ and *0.3*). It has been demonstrated that between the two scores, CTScore and ECGScore, there is a weak correlation, but statistically significant ($r = 0.2$ and $p = 0.01$) (figure no. 3, figure no. 4).

Figure no. 3. ECGScore and CTScore risk classes



Not the same can be said about the relationship between ECGScore and PESI score or CTScore and PESI score.

Figure no. 4. ECGScore- CTScore correlation



DISCUSSIONS

Characteristics of patients included in our study were similar to other studies: PIOPED, ICOPER, RIETE Registry, ZATPOL Registry, Columbus or Thésée. Compared to the before mentioned studies, the average age of the subjects taken into study (66.64 ± 16.2 years) was similar to that of ZATPOL Registry's patients (67 ± 15year).(19) Mortality in our study was reported in 0.6% within 24 hours, 9.6% in the first month and 12% for a year; the data we obtained are similar to those in the literature which states for mortality 30 day all cause a proportion of approximately 11%.(20) Ultrasound measurement results are not consistent with the literature which cites that the ratio VD / VS> 1 and especially kinetic disorders of the free wall of the right ventricle have especially prognostic parameter value.(5) In our study, none of the ultrasound parameters correlate with the mortality of 30 days or 1 year, but the presence of ventricular akinesia has been associated with immediately mortality. Based on PESI score patients in the study were divided into five risk classes as follows: Class I (<=65 points) - 12.1%, with a 30-day mortality of 0%, class II (66 -85 points) - 14.5%, with a mortality rate of 0.3%, class III (86-105 points) - 21.2%, class IV (106-125 points) - 18.5%, the mortality of 2.7% and Class V (>=125puncte) - 20%, with a death rate of 3.9%. 1 year death rate for the class of risk Class I is 0%, 0.6% class II, class III is 2.1%, 2.7% class IV and class V-5.1%. The results are comparable to those from a study of Korean, whose risk class distribution was 23% for class I, class II -32%, class III -25%, class IV-9%, class V-11 %, with 30-day mortality of 0% and 10.3%, 9.1%, 0% and 50%.(20) Pesi score correlates with mortality at 30 days, correlation statistically significant, $p = 0.009$ and also with one year death rate, p is $0,001$. For ECGScore, there is shown an association with mortality at 24 hours, $p = 0.05$, but there were no correlations with the rate of death in 30 days or 1 year. Based on statistical tests can be said that for patients in the high risk class based CTScore, mortality is increased in the first 24 hours ($p < 0.001$), but this score can not be considered a prognostic factor for 30-day mortality / 1 year. It has been demonstrated that between the two scores, CTScore and ECGScore, there is a weak correlation but statistically significant ($r = 0.2$ and $p = 0.01$). From the highlighted above, we extract the main idea that pure imaging scores can not be prognostic factors, especially on long term. Evolution of PE patients depends heavily on status of each patient at the time of onset of disease, associated pathologies and optimal treatment choice, critical factors that can not be neglected.

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