PULMONARY EMBOLISMS ARE ASSOCIATED WITH ECHOCARDIOGRAPHIC EVIDENCE OF RIGHT VENTRICULAR STRAIN

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SUMMARY

Delays in the diagnosis and treatment of pulmonary embolism can prove fatal. Readily available noninvasive techniques would be quite useful in the early diagnosis of this potentially lethal condition. Pulmonary embolisms are associated with evidence of right ventricular pressure overload on echocardiogram. Correlation was found between pulmonary embolism and combination of raised pulmonary artery pressures, right ventricular dilatation and hypocontractile right ventricle on echocardiogram. Echocardiogram is an important noninvasive tool in the diagnosis of pulmonary embolism.

INTRODUCTION

Great importance is attached to the consideration of risk factors and clinical suspicion in the diagnosis of pulmonary embolism. Symptoms associated with pulmonary embolism are varied and may mimic other illnesses. Most deaths associated with pulmonary embolism occur because of delays in establishing the diagnosis and in starting appropriate therapy.

Ventilation-Perfusion lung scans are not always conclusive and are some times nor readily available. Pulmonary arterial angiogram is the definitive diagnostic test for pulmonary embolism but it is an expensive invasive procedure. Both diagnostic tests require specialized equipment and staff, and these at times may not be available on short notice.

Pulmonary embolism leads to raised pulmonary artery pressures and this in turn
causes right ventricular pressure overload (Table 1). Various echocardiographic changes have been described to be associated with pulmonary embolism (Table 2).

The purpose of this study was to determine the frequency of echocardiographic changes suggestive of right ventricular strain pattern in patient with pulmonary embolism.

**MATERIAL AND METHODS**

This study evaluated all patients who had ventilation perfusion lung scans performed for suspicion of pulmonary embolism at East Carolina University School of Medicine/Pitt Country Memorial Hospital, Greenville, North Carolina, USA between January 1998 and October 1999. Patients selected were those who had a high probability ventilation perfusion lung scan for pulmonary embolism and who had an echocardiogram done. Echocardiograms were analyzed for evidence of right ventricular strain pattern, a combination of; dilatation & hypokinesia of right ventricle, deviation and/or paradoxical motion of interventricular septum and elevation of right ventricular/pulmonary artery pressures. Patients with evidence of pulmonary valve stenosis and patients with right ventricular free wall thickness of >0.5 mm, were excluded. The internal diameter of the right ventricle at end diastole was measured form the parasternal long axis. The right ventricular dimension was taken as the maximum distance between the endocardium of the right ventricular free wall and the interventricular septum. The measurement was made a the onset of the R wave of a simultaneously recorded electrocardiogram. The motion of interventricular septum was assessed in the parasternal short axis and was regarded as abnormal if the septum remained flattened or consistently bulged towards the left ventricle in diastole. Continuous wave doppler echocardiogram was used to estimate the peak velocity of tricuspid regurgitation. This was used to calculate systolic right ventricular/systolic pulmonary artery pressures. Tricuspid regurgitation velocity of over 3.2 meter/second was considered as representing moderately elevated right ventricular/pulmonary artery pressure.

Statistical analysis was done using the chi square.

**RESULT**

Thirty-five patients were identified who had a high probability ventilation perfusion

**ECHOCARDIOGRAPHIC FINDINGS ASSOCIATED WITH PULMONARY EMBOLISM**

- Dilated right ventricle
- Hypocontractile right ventricle
- Raised right ventricular pressures
- Leftward deviation of interventricular septum
- Paradoxical motion of interventricular septum
- Pulmonary artery dilatation
- Raised inferior vena cava pressures
- Right to left shunts across patent foramen ovale
- Small left ventricular cavity
- Hyperdynamic left ventricle
- Intracardiac thrombi in transit

**TABLE 2**
PULMONARY EMBOLISMS ARE ASSOCIATED WITH EVIDENCE OF RIGHT VENTRICULAR STRAIN PATTERN ON ECHOCARDIOGRAM (P<.05)

<table>
<thead>
<tr>
<th>Total Number of patients with Pulmonary Embolisms</th>
<th>Echocardiograms showing RV strain</th>
<th>No RV strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>24</td>
<td>11</td>
</tr>
</tbody>
</table>

TABLE 3

scan and an echocardiogram done. There were 20 males and 15 females. Age of the patients ranged from 28 to 85 years, mean age was 59 years. Twenty-four out of these 35 patients had evidence of right ventricular strain as defined per protocol. Eleven out of these 35 showed no evidence of right ventricular strain (p value >.0.5) (Table 3). Only one echocardiogram demonstrated a thrombus in transit in the right atrium.

DISCUSSION

A thrombus in transit is some times visible on an echocardiogram but mostly findings are related to the response of right ventricle to an acute pressure overload. These include right ventricular dilatation and dysfunction (asynery of the right ventricular free wall)². The interventricular septum may be deviated towards the left ventricular cavity secondary to raised pressure in the right ventricle. Paradoxical septal bulging in diastole occurs as a consequence of both right ventricular dilatation and simultaneous reduction in left ventricular preload caused by pulmonary embolism, which decreases the left to right ventricular diastolic pressure gradient³. Right atrial pressure are increased and this leads to raised inferior vena cava pressures and its failure to collapse during forced inspiration⁴. Reduced cardiac output leads to a smaller left ventricular cavity and a hyperdynamic left ventricle⁵.

Increased right sided pressures may cause shunting of blood through a patent foramen ovale from right to left, and may cause paradoxical embolization of a thrombus towards the systemic circulation for similar reasons. These findings, suggestive of right ventricular strain pattern resolve after clot regression and anticoagulation therapy²⁷. When patients with known pulmonary disease present with suspicion of pulmonary embolism, echocardiography may not be very helpful as such patients have at least overload. However, right ventricular free wall thickness >0.5 mm may suggest non-acute events e.g. long standing pulmonary hypertension⁶. Right ventricular infarct may also present with a combination or right ventricular systolic pressure overload and dilatation of right ventricle, but the peak tricuspid regurgitation velocity is low in this condition as compared to pulmonary embolism.

In this study we excluded patients who had right ventricular free wall thickness of >0.5 mm. Patients with tricuspid regurgitation velocity of >3.2 meter/second were also excluded as it represented a right ventricular/pulmonary artery pressure of >40 mmHg. Our yield for picking up right ventricular strain could have been much higher if we had considered all patients with right ventricular pulmonary artery pressures of >25 mmHg. This study shows that echocardiograms could be useful in the diagnosis of pulmonary embolism in the initial stages of management.

REFERENCES

2. Come PC, Kim D, Parker JA, Goldhaber SZ, Braunwald E, Markis JE. Early reversal of right ventricular dysfunction in patients with


