Multiplanar and 3D Imaging Modalities for the Evaluation of Right Ventricle to Left Ventricle Ratios in Patients with Pulmonary Embolism

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Background

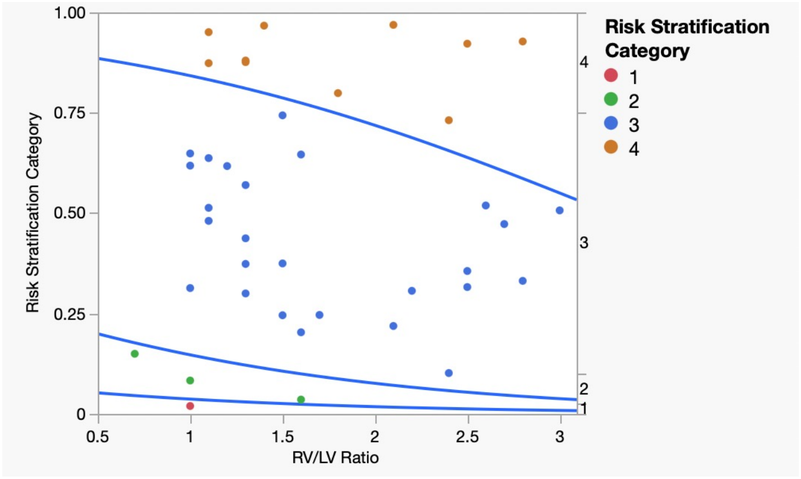
Acute pulmonary embolism (PE) is a major cause of cardiovascular morbidity and mortality [1]. PE may induce rapidly progressing sequelae, including death, necessitating prompt diagnosis and treatment [2-3]. Moreover, early risk stratification is essential in order to determine effective therapeutic management [4-5]. Right ventricle to left ventricle (RV/LV) ratio measurement is a strong predictor of clinical outcomes, such as mortality, with the potential for further prognostic applications [1,4,7]. Computerized tomographic pulmonary angiography (CTPA) is an accessible method often used for rapid measurement of RV/LV ratios. Measurement of RV/LV ratio is often performed in the standard axial view, which may not represent the true maximum diameter [6]. Moreover, RV/LV ratios based on diameter may not demonstrate the full extent of RV dilation and dysfunction [8].

Objectives

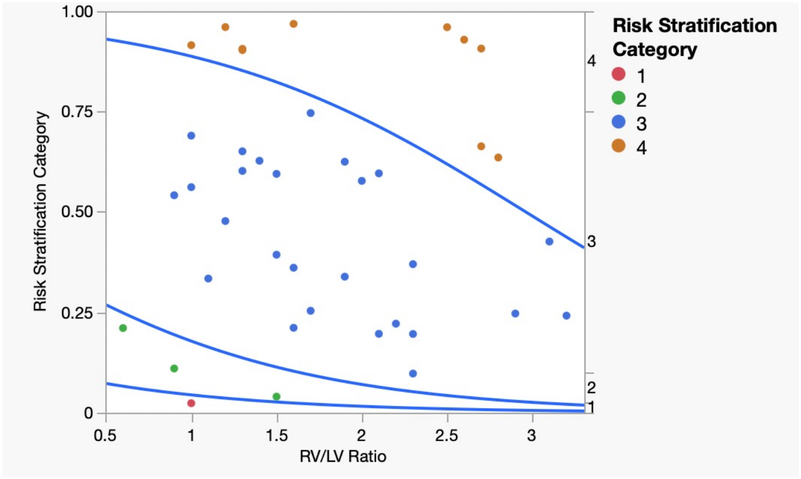
- This study measures RV/LV diameter ratios in a standard axial view and a reformatted four chamber RV/LV ratio. This study also measures RV/LV volume ratios using 3D imaging modalities.
- This study compares standard axial, reformatted four chamber, and 3D volume RV/LV ratios as predictors of pulmonary embolism severity and RV dysfunction.

Methods

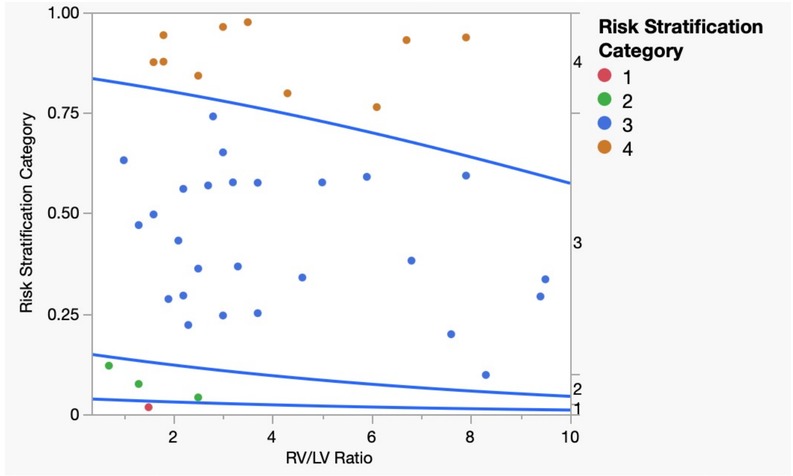
This retrospective review includes patients with acute massive PE from June 2015 to March 2023. An internal procedural database was queried and patients with imaging-confirmed acute PE were included (n=216). Patients without pre-intervention CT or axial thin slices available for analysis were excluded. Diameter-based RV/LV ratios were measured in the standard axial view. Diameter-based RV/LV ratios were then measured using multiplanar imaging modalities in Visage to obtain a reformatted four-chamber view that considers the anatomical axis of the heart. Subsequently, using 3D region of interest (ROI) modalities in Visage, the RV/LV ratio was calculated by obtaining the volume measurement of each ventricle. RV/LV ratios were correlated with Tricuspid Annular Plane Systolic Excursion (TAPSE) as a measure of RV dysfunction. RV/LV ratios were also compared to American Heart Association/European Society of Cardiology classifications of pulmonary embolism severity: 1= Low Risk, 2= Intermediate Low Risk 3= Intermediate High Risk, 4= High Risk [9].



Regression 1: Standard Axial View RV/LV Diameter Ratio as a Predictor of PE Severity Classification



Regression 2: Reformatted Four Chamber RV/LV Diameter Ratio as a Predictor of PE Severity Classification



Regression 3: 3D RV/LV Volume Ratio as a Predictor of PE Severity Classification

Results

Preliminary data (n=41) shows axial and reformatted four-chamber ratios were well correlated (correlation coefficient, 0.777), and axial and 3D volume ratios were well correlated (correlation coefficient, 0.817). Logistic regression showed RV/LV ratios measured with the reformatted four-chamber view were significantly associated with pulmonary embolism severity classifications, and that larger RV/LV ratios measured in this view predicted greater pulmonary embolism severity classification (coefficient, -1.5; p=0.0434). RV/LV ratios measured with the standard axial view (coefficient, -0.737; p=0.162) and 3D volume modalities (coefficient, -0.137; p=0.304) were not statistically associated with pulmonary embolism severity classifications. Preliminary data (n=17) showed no statistically significant association between standard axial (p=0.130), formatted four-chamber (p=0.0897), and 3D volume measurements (p=0.209) of RV/LV ratio and TAPSE.

Conclusion

Preliminary data suggests a reformatted four-chamber measurement of RV/LV ratio better predicts pulmonary embolism severity classification than standard axial or 3D volume measurements. Preliminary data does not suggest an association between various RV/LV ratio measurements and TAPSE as a predictor of RV dysfunction. More complete data is needed to assess these methods of RV/LV volume ratio measurement as a means of risk stratification and prognostication for patients with acute PE.

References

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