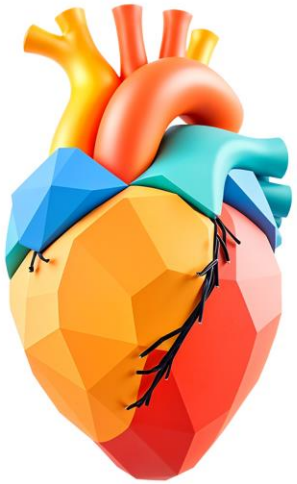

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12th Annual Tehran Heart Center Congress

7th CRITICAL CARDIOVASCULAR CARE

دوازدهمین کنگره سالیانه مرکز قلب تهران

2025

۲۵ و ۲۶ بهمن ماه ۱۴۰۳

13 & 14 February

Tehran Heart Center

Tehran, Iran

How Echo Transforms the Diagnosis and Treatment of Acute Pulmonary Embolism

Dr Atoosa Mostafavi

Cardiologist, Fellowship of echocardiography

Associated professor of TUMS

55 year old female , presented with acute onset breathlessness, one episode of loss of Consiousness with a recent history of pain and leg swelling in the right calf.

Clinicaly she had tachycardia, thachypnea and desaturation with unremarkable systemic examination.

No cyanosis, no rales , no clubbing

Vital sign:

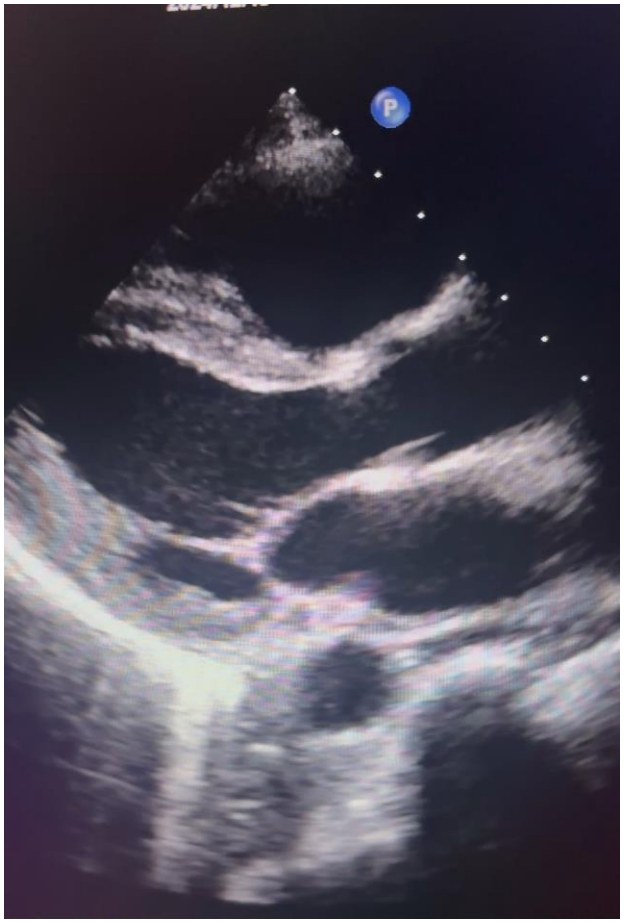
Temprature: 37 c

BP=135/85 mmH

HR=116 bpm

RR: 26/min

ECG: Sinus tachycardia, Incomplete RBBB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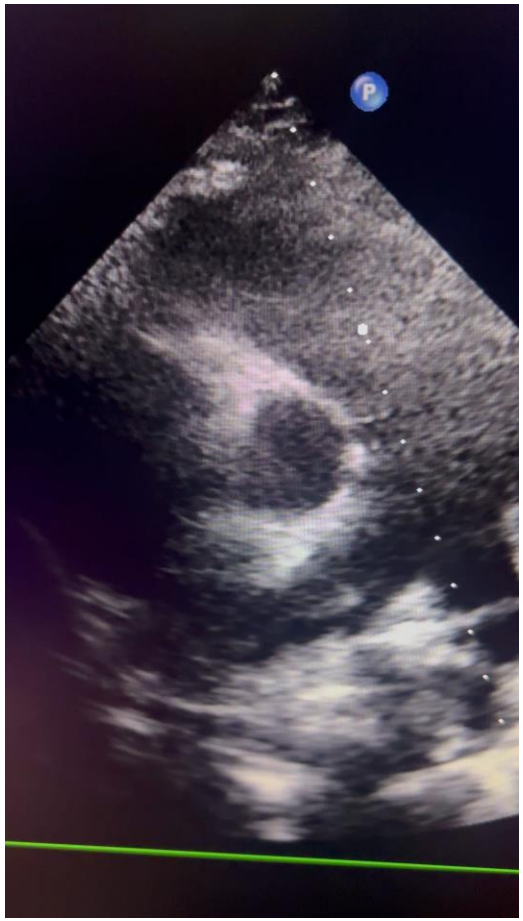
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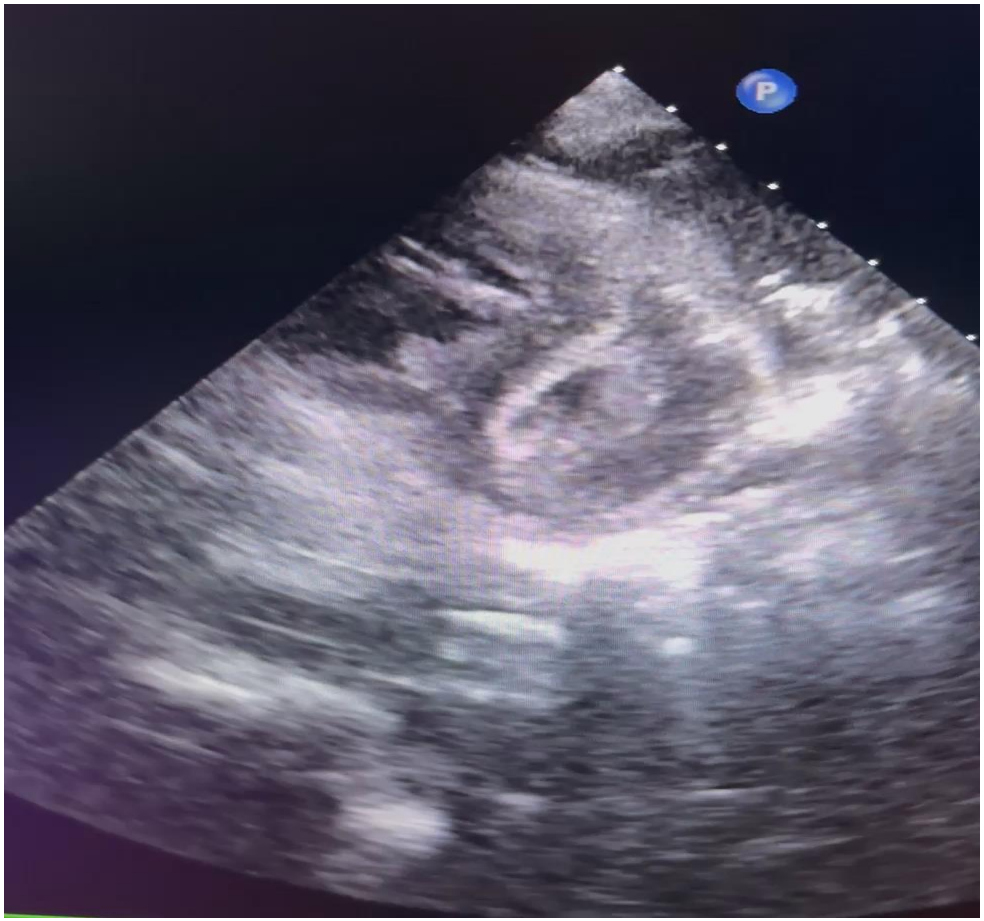
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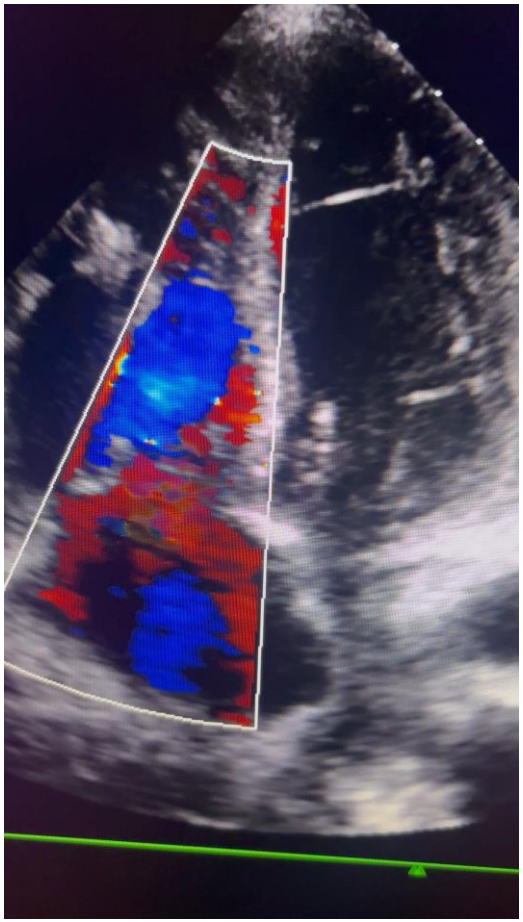


The role of echocardiography ?

- Echo is to primarily risk stratify patients and in some situations can help confirm the diagnosis of PE in patients with high pretest probability (emphasizing the importance of pretest probability in these patients.)

- With a sensitivity of approximately 50% and a negative predictive value of 40% to 50%, a negative echocardiogram does not completely rule out a PE.

- Hence, it does not perform well as a screening tool.

- Can be useful in the management of PE, mainly as a prognostic tool and less often as a diagnostic tool.

- It can be used to assess for RV dysfunction if PE is suspected and CT-PA is not immediately available or is clinically contraindicated.

- In hemodynamically unstable patients with acute PE, echocardiographic detection of right ventricular dysfunction is an indication for administering thrombolytics

Potential roles of Echo for evaluation of known or suspected PE

1)Contribute to the diagnosis (indirect).

2) Evaluate the hemodynamic consequences .

3) Determine management.

4) Assess the cardiopulmonary responses to therapeutic interventions.

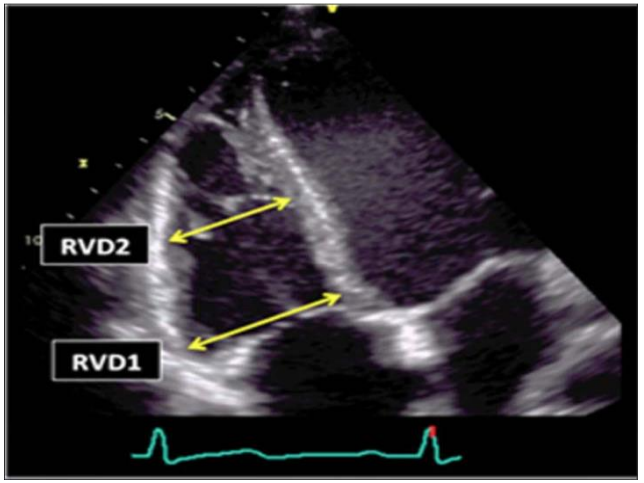
5) Exclude other entities

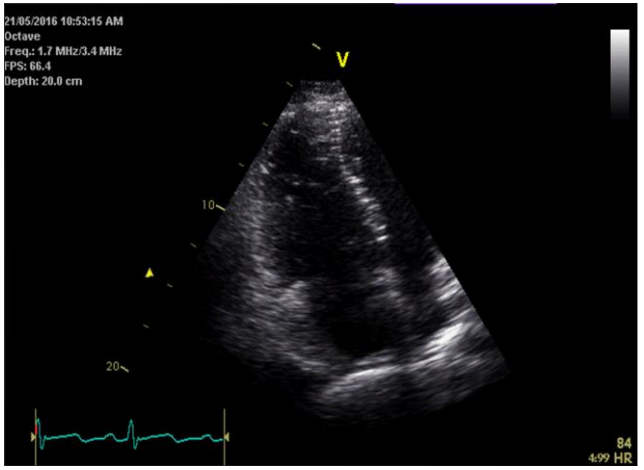
❖Echocardiographic diagnostic assessment of PE includes the following components:

- RV size
- RV systolic function including (TAPSE, FAC, TAPSE/PASP ratio, LVOTVTI, RVOT VTI, PASP/left ventricular stroke volume (LVSV)
- McConnell's sign
- the 60/60 sign
- visualization of thrombus in transit.

Right Ventricular Dilatation

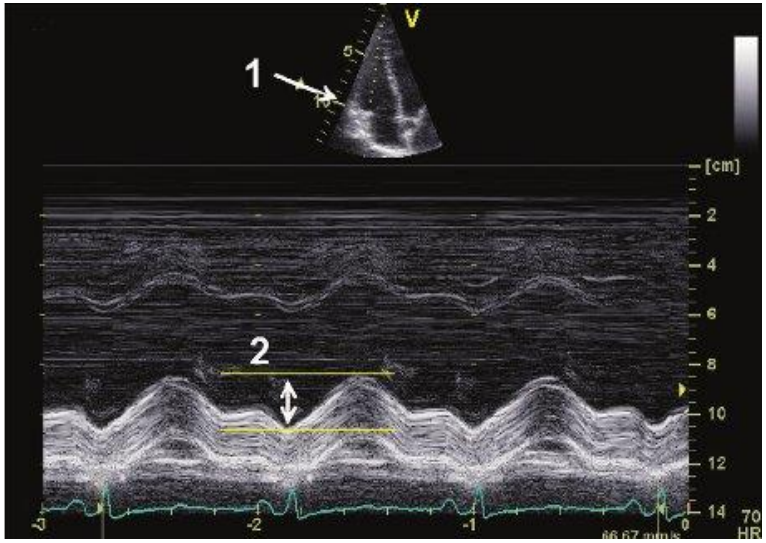
- RV should appear < 2/3 the size of LV on 4 ch view
- RV measurements should be made from an RV-focused view on an apical 4-chamber view.
- A basal diameter of >41 mm or midlevel diameter of >35 mm indicates RV dilatation



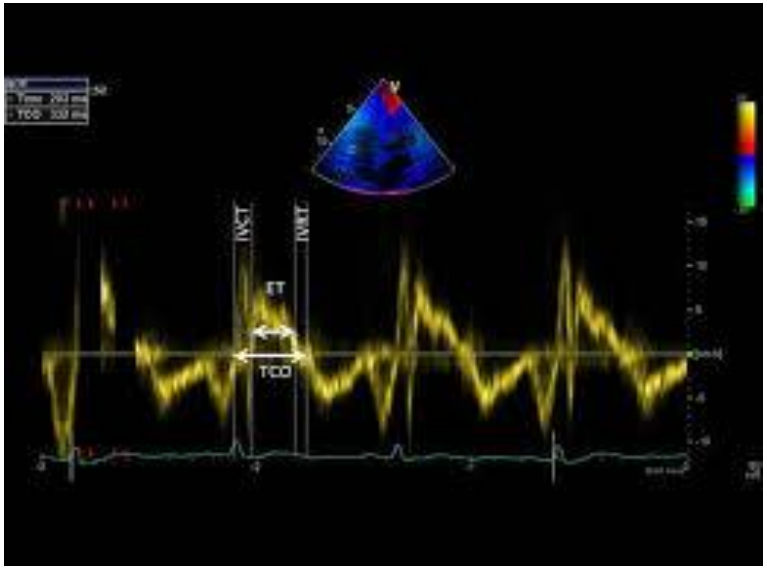


Parameters of RV Systolic Function

- TAPSE, FAC, free wall strain, Tei index, and S' velocity
- TAPSE <1.7 cm is indicative of RV dysfunction.
- On occasion, it can give artifactually high or low values for RV function due to heart motion.



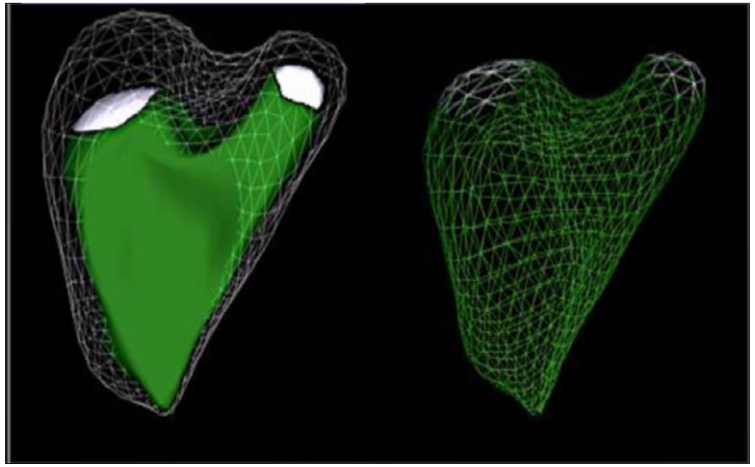
- Tei index or MPI is a measure of global RV function. (ICT+IVRT/ET).
- <0.43 when obtained by PW Doppler < 0.54 when obtained by tissue DI is considered normal.
- However, the Tei index, regardless of method of measurement, can be falsely low in conditions with elevated right atrial pressures



- FAC
- This is a measure of both radial and longitudinal RV function. (Normal >35%)

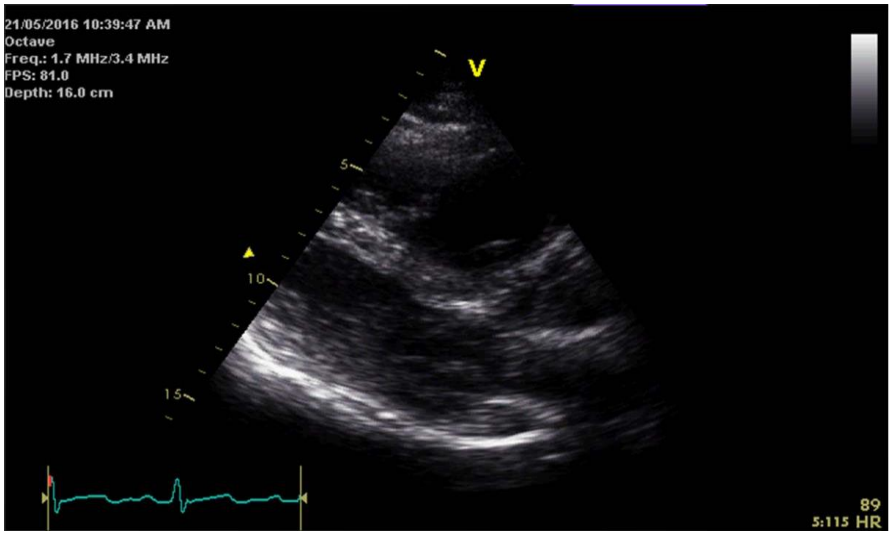
- RV global longitudinal free wall strain
- > –20% (<20% in absolute value) is abnormal

- RV lateral annular systolic velocity (S')
- consists of the highest systolic velocity of RV excursion.
- reproducible for the basal segment of the RV free wall, not for mid and apical segments.



- MPI and FAC --------- global RV function,
- TAPSE, S', free wall strain ----- longitudinal function.
- longitudinal function contributes more to the RV stroke volume than the radial function
- Relying only on measures of longitudinal function may be inadequate in evaluating the global function
- Due to regional variation of the RV in PE, parameters of longitudinal function can be falsely normal , and hence further assessment with a global function parameter would help characterize RV function accurately.

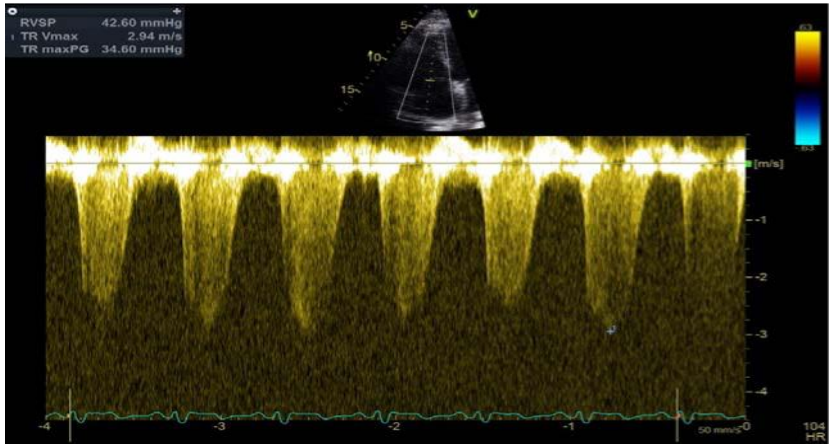
- Normal or hyper dynamic LV



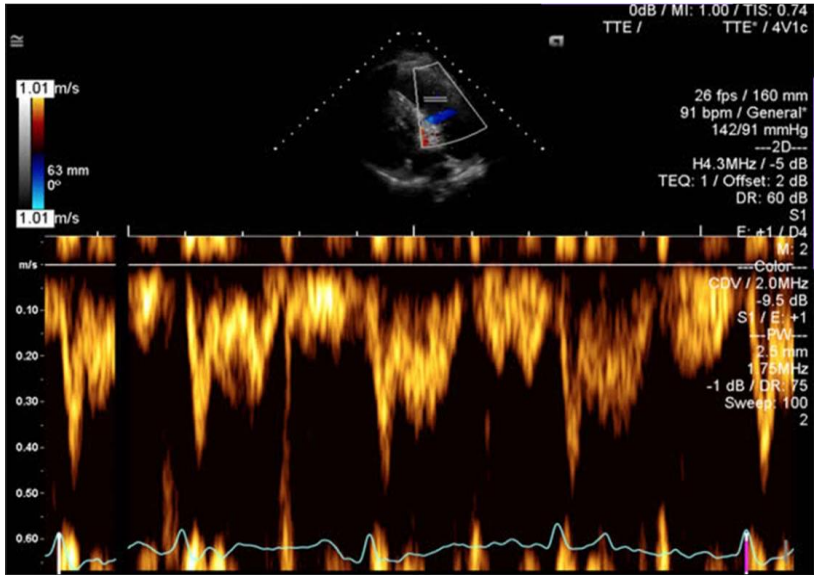
- Septal flattening, D shape septum

Measure of Increased RV Afterload

- *The 60/60 Sign*



- *Early Systolic Notching (ESN).*

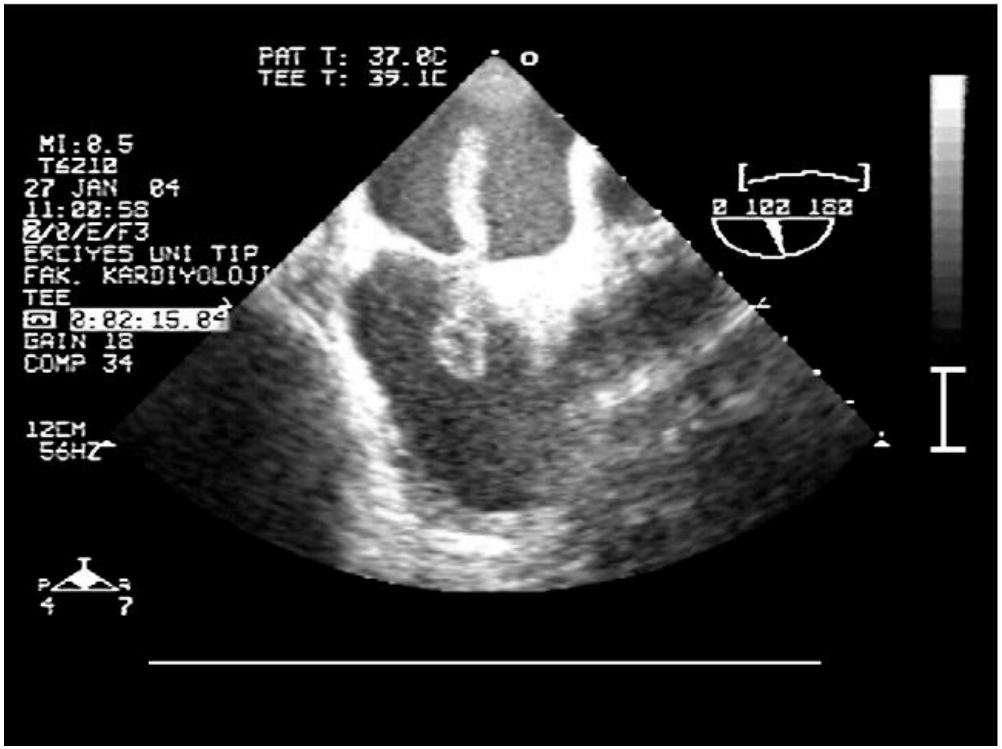


- McConnell's sign

- Decreased RV free wall motion with preserved RV apical motion

- The 60/60 sign : TR gradient < 60 mm Hg + PVaccT < 60 ms.
- more objective and reproducible compared with McConnell's sign.
- When the 60/60 sign was combined with McConnell's sign------- sensitivity of 36% and specificity of 94% in diagnosing acute PTE.
- ESN seen in 92% of patients with acute intermediate-risk or high-risk PE, and only in 2% of subsegmental PE.
- In emergency room it had a specificity of 97% and sensitivity of 34%
- However, can also be seen in several other conditions that can cause PH , such as COPD, OSA, and VHD
- The physiology underlying ESN is that, with increased PVR, RV forward flow is impeded by the retrograde pressure wave that arrives early in systole and can be indicator of the inability of RV to cope with the increasing afterload and a marker of ventriculoarterial uncoupling

- Thrombosis in transit



Echocardiographic prognostic assessment of PE includes the following components:

- RV function
- TAPSE/PASP
- *LVOTVTI and RVOT VTI*
- *PASP/LVSV*
- *ESN*

- RV Dilatation, Dysfunction, and Failure and hemodynamic decompensation in acute PE is caused by an increase in RV afterload from increased PVR.

- Right ventricular dysfunction has been seen in 31% of normotensive patients with PE, and these patients had an increased risk of hemodynamic decompensation and in-hospital mortality.
- Consequently, it is crucial to identify these patients who will need escalation of therapies beyond anticoagulation.

TAPSE/PASP

- RV responds to an increase in afterload by increasing contractility.
- With increasing afterload and RV dysfunction, RV dilation and RV uncoupling occur.
- A ratio of TAPSE/PASP <0.4 can predict the risk of hemodynamic deterioration and/or mortality in patients with acute PE.
- A normal TAPSE/ PASP ratio is 0.8 to 1.8.
- The ratio might not accurately represent the relationship between RV function and increasing afterload. Ratio might be overestimated in a situation wherein a failing RV might not be able to develop high PASPs.
- On the contrary, in patients with chronic PH, the ratio will be lower than what is found in acute PE.
- This is because RV has a greater amount of time to adapt to the increasing afterload. In these situations, PAP can increase to high levels resulting in a lower ratio.
- Despite the above-mentioned limitations, this indicator can be useful as a prognostic tool in the appropriate clinical setting

Measures of SV (*LVOTVTI and RVOT VTI)*

- An LVOT VTI < 15 cm and RVOT VTI < 9.5 cm have been shown to predict adverse outcomes.

Ratio of PASP and LVSV (PASP/LVSV).

- A measure of RV afterload for risk stratification in intermediate- to high-risk PE patients

- Kamran et al (Journal of the American Heart AssociationVolume 10, Number 18 https://doi.org/10.1161/JAHA.120.01984)

found that patients with a PASP/LVSV of >1.0 mm Hg/ mL outperformed traditional PE risk stratification scores and were more likely to predict intermediate- or high-risk PE.

- In hemodynamically significant acute PE, hypotension results from a reduced LVSV, due to reduced filling from a failing RV in the setting of increased PAP

- Therefore, with increasing PAP and/or a reduced LVSV, this ratio will worsen, reflecting the performance of both the RV and the LV.

- When LVEF was evaluated in patients with higher and lower ratios, the authors noted no difference, suggesting that LVEF had no role in predicting worse outcomes in these patients.

- It was also seen that this ratio predicted outcomes better than LVOT VTI and RVOT VTI in patients that have not yet deteriorated.

Early systolic notching

- It is important to differentiate ESN from late systolic notching, which has been defined as notching in the terminal aspect of the Doppler signal without 2 distinct peaks.
- Even though patients with late systolic notching also have elevated PAP , they have a lower PVR and higher pulmonary artery compliance when compared with patients with earlier notching.
- While the presence of ESN can at least be used to risk stratify patients into the intermediate-risk category, the role of ESN as a prognostic marker is questionable.

Echocardiographic therapeutic assessment of PE includes the following components:

When to consider thrombolysis?

- Severe or worsening right ventricular dysfunction ("submassive PE")
- Cardiopulmonary arrest due to PE (eg, BP >90 mmHg after resuscitation)
- Extensive clot burden (eg, large perfusion defects on ventilation/perfusion scan or extensive embolic burden on computed tomography)
- Free-floating right atrial or ventricular thrombus

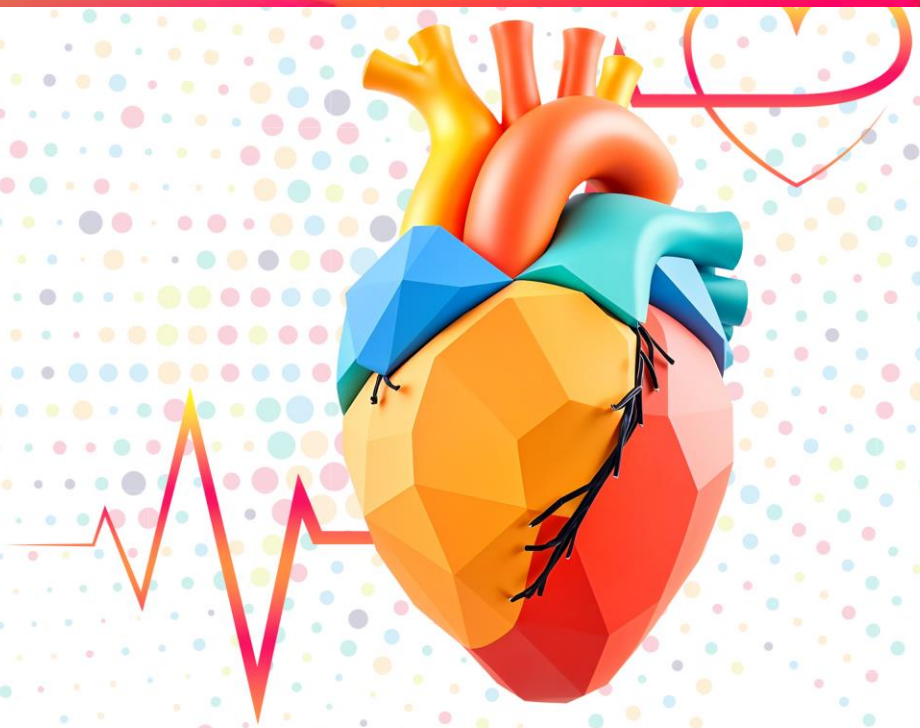
- Which of the following patients with acute PTE has a worse prognosis?

- Patient 1:
- Mac connel sign , 60-60 sign, TAPSE=1.7 cm, TAPSE/PASP=0.9

- Patient 2:
- ESN, TAPSE=1.7cm , PASP/LVSV=1.2 mmHg/ml

THANK YOU

SLIDE



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