The Role of Echocardiography for the Diagnosis and Treatment of Prosthetic Valve Emergencies in the ICCU - Alik Sagie MD

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Prosthetic valve emergencies in the ICU

- Acute dysfunction of prosthetic valves may cause hemodynamic deterioration resulting in pulmonary edema or cardiogenic shock and should be considered in its differential diagnosis.
Valvular emergencies in the ICU

- A rapid diagnosis of a valvular etiology in a patient with acute hemodynamic deterioration is very important because emergency interventions such as:
  - intensive medical therapy,
  - emergent valve replacement
  - new percutaneous valve procedures
can be effective, and, at times, life saving
Diagnosis of PV Emergencies

- Clinical clues (from the patient's history, symptoms and signs) suggesting valvular etiology are very important but often difficult to get in patient in pulmonary edema or cardiogenic shock
Diagnostic tools in prosthetic valve emergencies

Therefore, echocardiography (TTE, TEE or 3D echo) is the best imaging modality to diagnose the etiology of acute hemodynamic deterioration and should be performed as soon as possible.

This diagnostic tool can be done at bedside without the need to transfer the patient away from the intensive care setting to CT or MRI laboratory where monitoring of the patient is not ideal.
Bedside availability
TTE Vs. TEE in Prosthetic valve Emergencies
TTE in patients with prosthetic valve malfunction

- TTE is safe and fast in identifies MANY of cardiac causes of a shock or pulmonary edema in a critically ill patient in the ICU, however, in case of prosthetic valve malfunction especially in mechanical valves it is limited due to many artifacts and usually TEE is needed to complete the study

Josef MZ et al, *Chest.* 2004;126:1592
TEE Advantages

TEE has the following advantages over TTE:
- Patients on respirators
- Post-cardiac surgery patients

Better diagnostic capabilities and definition in:
- Prosthetic valve complications
- Acute IE
- Acute MR and AR
- Aortic dissection and mural hematoma
- Pulmonary emboli
Disadvantages of TEE in critical ill patients in the CCU

- It requires **sedation**, which may compromise the borderline respiratory and hemodynamic status of the critically ill patient.

- **TEE-related complications** (rare):
  - aspiration pneumonia,
  - esophageal injury
  - Bronchospasm
  - Dislodgment of endotracheal tube
  - Unsafe in severe coagulopathy
  - Difficult to conduct in facial trauma
Limitations of 2D TTE/TEE

- Analysis of complex anatomic structures
- Spatial orientation
- Relationship between structures and devices
Advantages of real time 3D TEE

- Real time 3D visualization of cardiac anatomy without any reconstruction
- Getting surgical views of the valves
- Enhanced analysis of the relationship between cardiac structures and devices
- Improvement in guidance of complex procedures
PV Emergencies in ICCU
Aortic prosthesis

- **Prosthetic valve regurgitation**
  - Endocarditis
  - Degenerated biologic valves
  - Stuck mechanical valve
  - Severe paravalvular leak

- **Prosthetic valve stenosis – stuck valve**
  - Valve thrombosis
  - Valve Pannus
  - Endocarditis
Acute aortic valve prosthesis regurgitation
<table>
<thead>
<tr>
<th>Variable</th>
<th>Aortic Regurgitation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acute</td>
</tr>
<tr>
<td><strong>Auscultatory</strong></td>
<td></td>
</tr>
<tr>
<td>Diastolic murmur</td>
<td>Soft, early</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_1$</td>
<td>Soft</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_2$</td>
<td>Loud $P_2$</td>
</tr>
<tr>
<td>$S_3$</td>
<td>Present</td>
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<tr>
<td><strong>Hemodynamic</strong></td>
<td></td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Decreased</td>
</tr>
<tr>
<td>Pulse pressure</td>
<td>Normal or decreased</td>
</tr>
<tr>
<td>Systolic pressure</td>
<td>Decreased</td>
</tr>
<tr>
<td>LVEDP</td>
<td>Severely increased</td>
</tr>
<tr>
<td>Left ventricular size</td>
<td>Normal</td>
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</tbody>
</table>
Echocardiographic evaluation of AR

AR - regurgitant jet
# Aortic regurgitation severity

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angio</td>
<td>1 +</td>
<td>2+</td>
<td>3-4+</td>
</tr>
<tr>
<td>Doppler jet area</td>
<td>&lt;25% LVOT</td>
<td>25% - 65%</td>
<td>&gt;65%</td>
</tr>
<tr>
<td>Vena Con</td>
<td>&lt; 3 mm</td>
<td>3-6 mm</td>
<td>&gt;6mm</td>
</tr>
<tr>
<td>Reg Vol</td>
<td>&lt;30 ml</td>
<td>30 -60 ml</td>
<td>&gt;60 ml</td>
</tr>
<tr>
<td>ERO cm²</td>
<td>&lt; 0.1</td>
<td>0.1- 0.29</td>
<td>&gt; 0.3</td>
</tr>
</tbody>
</table>
Premature mitral valve closure in acute aortic regurgitation by M-mode echo
Valve hemodynamics: Acute vs. Chronic AR
Holo-diastolic flow reversal in the distal aorta
Clinical examples
Acute AR due to degenerated xenograft

- A 76 old man underwent AVR- xenograft 11 years ago
- Admitted to the ICCU with Pulmonary edema and hypotension
- History of significant COPD
- 6 month before index hospitalization routine echocardiogram reveal moderate AR due to degenerated xenograft and he was clinically stable at that time
DD: Acute AR due to Degenerated valve with mobile torn leaflets
Acute AR due to IE with mobile vegetations
2D – TEE – Severe AR

VC = 9 mm
Doppler trace of acute AR
Follow up

- The patient was referred to emergent AVR (within 24 Hr) and recovered slowly after long hospitalization due to respiratory complications.
- Today in the era of percutaneous valve interventions “transfemoral “Valve in Valve” implantation could be a good alternative in an elderly patient with severe COPD.
Lesson

- When a patient with bioprosthetic malfunction degeneration develops bioprosthetic malfunction degeneration, the natural history is unpredictable and it's better to plan an elective operation earlier rather than waiting for an acute emergency such as happened in this patient.
An elderly patient with mechanical prosthesis who presents to the ICCU with pulmonary edema and hemolysis

**DD:** Intravalvular vs. Perivalvular leak
3D TEE COLOR FLOW
Percutaneous paravalvular leak closure
First device in place- residual AR
Residual AR after first device by color TEE
Catheter in second paravalvular hole
2 devices in place by 2D color flow TEE
Acute STEMI in a patient after AVR

- 52 years old woman with coronary risk factors
- 7 years ago she underwent AVR – bileaflet SJ mechanical prosthesis.
- She was admitted with typical angina and ECG consisted with anterior wall STEMI
- Coumadin therapy was interrupted for several days due to small surgery
- LAB results: troponin 0.6; CPK-440; INR 2.1
ECG on presentation

RBBB + ST elevation V3-V6
TTE
Technically difficult study

Prosthetic gradients
Peak = 46 mean= 24 mmHg

Apical akinesia
Cardiac Catheterization
2D transgastric TEE
Prosthetic gradients on TEE

Prosthetic gradients
Peak = 78
mean = 45 mmHg
3D TEE
Fluoroscopy
Treatment option

- Redo AVR
- High dose heparin
- Thrombolysis
Follow-up

- Initially high dose heparin was given with PTT over 80 second – no improvement in leaflets motions
- Thrombolytic treatment was than given – TPA 100 mg within 3 hours
- After 1 hour the patient developed severe chest pain
- On ECG ST elevation on inferior wall leads
ECG during thrombolytic therapy and chest pain

ST elevation inferior wall leads
Follow – up

- Thrombolytic therapy continued with the rational that the ischemic episode is due to emboli released from the prosthesis to obstruct RCA\CX artery.
- After completing thrombolysis treatment chest pain subsided and ST elevation resolved
ECG post thrombolysis

ST elevation
Resolved
Fluoroscopy post thrombolysis
Acute aortic bio-prosthesis obstruction due to infective endocarditis

A 64 yrs old patient with was admitted to the ICCU with shortness of breath and high fever.

He underwent AVR (xenograft) a year ago.
TEE

DD: Large obstructive vegetation
   Large obstructive thrombus
Doppler TEE

PG = 87 mmHg
MG = 60 mmHg
Clinical course

- Blood cultures revealed gram positive bacilli.
- **Endocarditis** causing severe prosthetic valve stenosis was diagnosed.
- IV Antibiotics were started.
- The patient was scheduled for surgery after the weekend since he was hemodynamically stable and it was felt by the surgeon that 3 days of IV antibiotics before surgery are important.
Follow-up

- 1 day later the patient suddenly developed shortness of breath cardiogenic shock and died
Lesson

- Biological valve obstruction due to large mass of infectious material is a true emergency situation (like stuck mechanical valve). Surgery should be performed immediately.
Emergent valve in valve implantation in a patient's severe prosthetic valve stenosis

- A 88 years old woman.
- S/P CABG X 2 and AVR - bioprosthesis 9 years ago
- Admitted because of intractable HF
TEE of degenerated bioprosthesis stenosis

PG = 67 mmHg
MG = 42 mmHg
Contrast injection after Core valve implantation
Summary

- **Echocardiography** is the imaging tool of choice for diagnosing valvular emergencies in the CCU.

- **TTE** is usually enough to diagnose the main reason for the patient's hemodynamic deterioration.
Summary

- **TEE** has a better diagnostic capabilities especially in patients on respirator or post cardiac surgery and in special clinical setting such as prosthetic valve complications and SBE

- **Real time 3D TEE** is a new tool that has some advantages for diagnosis of complex pathologies and monitoring interventions but its added value especially in the ICCU setting is still need to be evaluated
Summary

- Since surgical mortality rates remain high, new interventions such as:
  - **Thrombolysis** in stuck mechanical valve
  - **Valve in valve** implantation in degenerated bioprosthesis or
  - **Percutaneous closure** of severe AR due to paravalvular leaks

  **May be a good alternative in selected cases**
TAVR

Corevalve

29 mm Valve in Valve

Transfemoral – General anesthesia

Post-deployment

No residual AR per angiography

Post-deployment TEE

Min Transvalvular gradients

19/8 Trace of AI

Thank you
Valvular Emergencies in ICCU
Prosthetic Mitral Valve

○ **Acute Prosthesis regurgitation**
  - Endocarditis
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○ **Prosthetic stenosis – stuck valve**
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Intra valvular regurgitation in mitral bio-prosthesis
Case history

- A 50 years old women with RHD after 4 valve replacements surgery (redo MVR + TVR).
- Last operation was MVR 12 years ago and a bioprosthesis was implanted.
- She was admitted with pulmonary edema.
2D TEE
Real time 3D TEE
Valve in valve implantation
Live 3D echo during procedure
TEE during valve implantation
Balloon expandable valve implantation
Color TEE after valve in valve implantation
TEE post valve in valve implantation
3D TEE- POST
FOLLOW-UP

- The patient went home after 3 days
- 2 years after the procedure she is in FC 1