부천세종병원

ECMO & Rapid Response System

초음파검사 기록지의 활용

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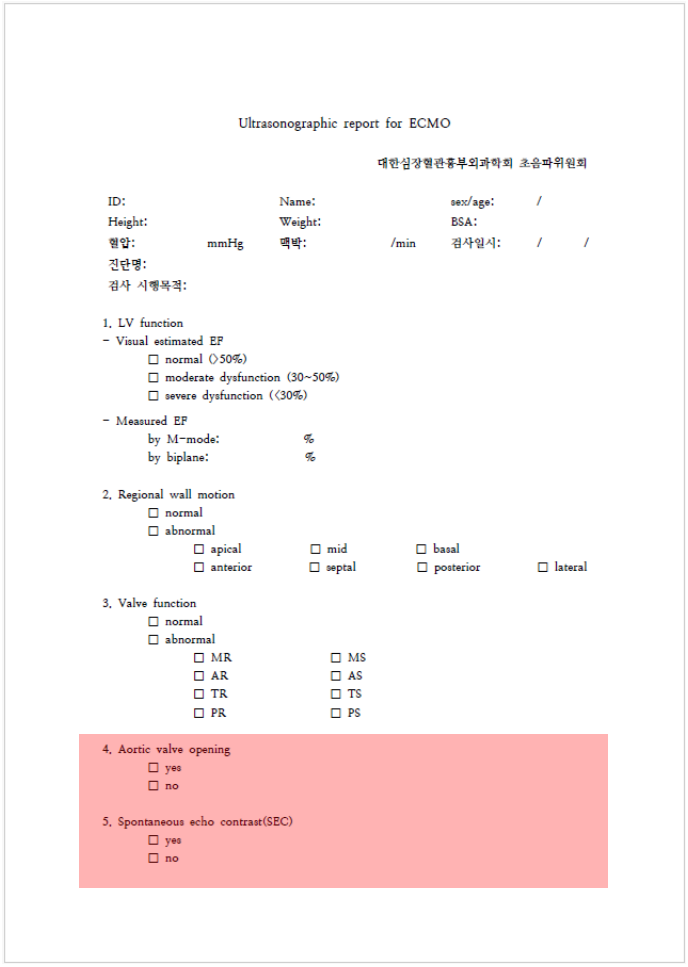
Ultrasonographic report : ECMO



Ultrasonographic report for ECMO

대한심장혈관흉부외과학회 초음파위원회

ID: Name: sex/age: /
Height: Weight: BSA:
혈압: mmHg 맥박: /min 검사일시: / /
진단명:
검사 시행목적:

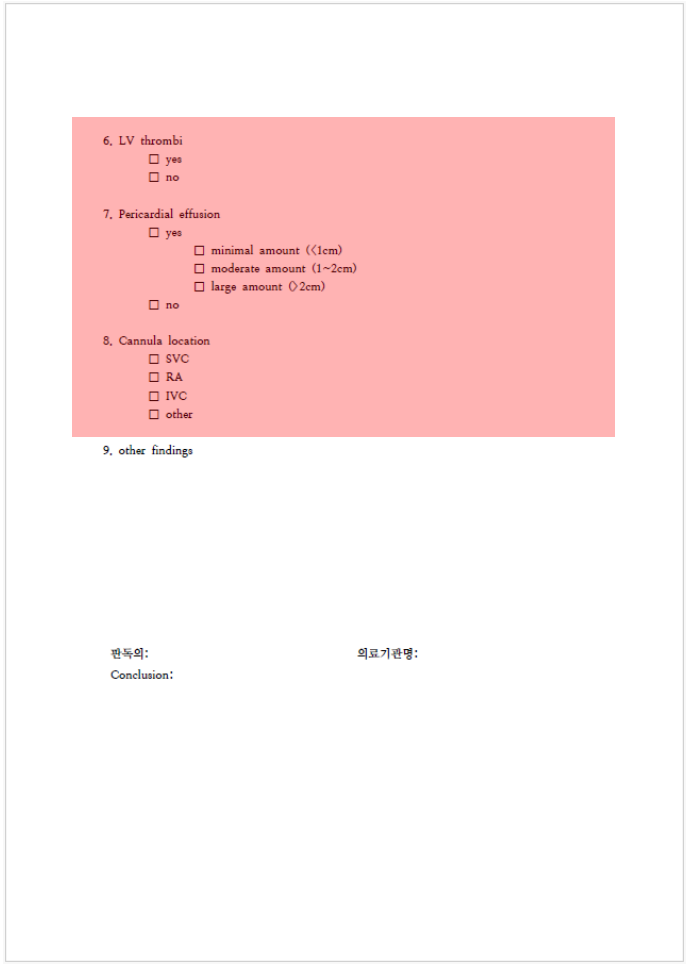
1, LV function
- Visual estimated EF
  - ☐ normal (>50%)
  - ☐ moderate dysfunction (30~50%)
  - ☐ severe dysfunction (<30%)
- Measured EF
  - by M-mode: %
  - by biplane: %

2, Regional wall motion
- ☐ normal
- ☐ abnormal
  - ☐ apical ☐ mid ☐ basal
  - ☐ anterior ☐ septal ☐ posterior ☐ lateral

3, Valve function
- ☐ normal
- ☐ abnormal
  - ☐ MR ☐ MS
  - ☐ AR ☐ AS
  - ☐ TR ☐ TS
  - ☐ PR ☐ PS

4, Aortic valve opening
- ☐ yes
- ☐ no

5, Spontaneous echo contrast(SEC)
- ☐ yes
- ☐ no



6, LV thrombi
- ☐ yes
- ☐ no

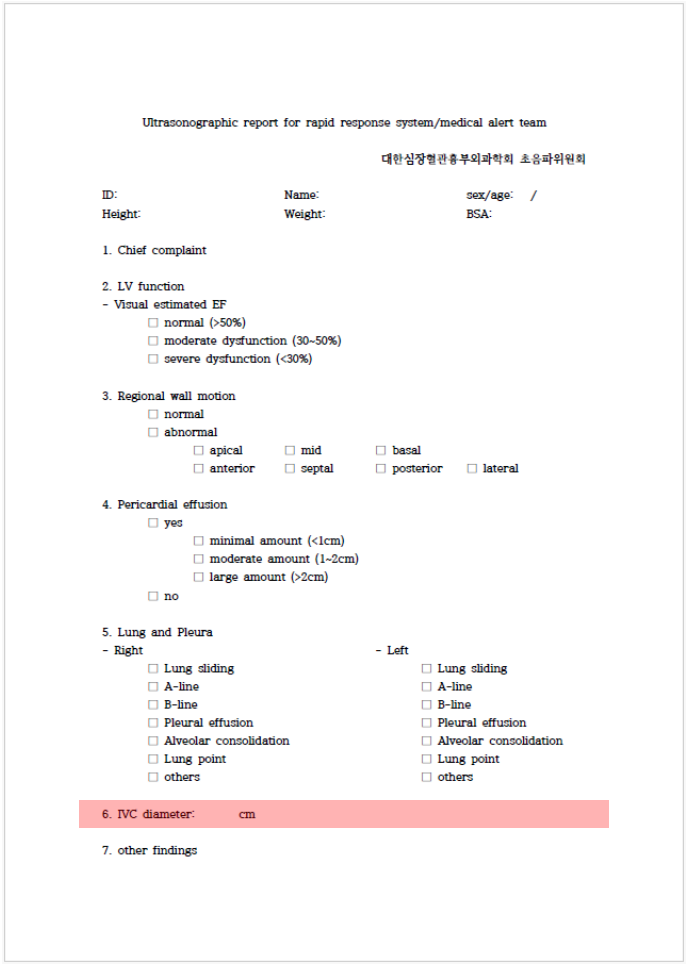
7, Pericardial effusion
- ☐ yes
  - ☐ minimal amount (<1cm)
  - ☐ moderate amount (1~2cm)
  - ☐ large amount (>2cm)
- ☐ no

8, Cannula location
- ☐ SVC
- ☐ RA
- ☐ IVC
- ☐ other

9, other findings

판독의: 의료기관명:
Conclusion:

Ultrasonographic report : RRT



Ultrasonographic report for rapid response system/medical alert team

대한심장혈관흉부외과학회 초음파위원회

ID: Name: sex/age: /
Height: Weight: BSA:

1. Chief complaint

2. LV function
- Visual estimated EF
  - ☐ normal (>50%)
  - ☐ moderate dysfunction (30~50%)
  - ☐ severe dysfunction (<30%)

3. Regional wall motion
  - ☐ normal
  - ☐ abnormal
    - ☐ apical ☐ mid ☐ basal
    - ☐ anterior ☐ septal ☐ posterior ☐ lateral

4. Pericardial effusion
  - ☐ yes
    - ☐ minimal amount (<1cm)
    - ☐ moderate amount (1~2cm)
    - ☐ large amount (>2cm)
  - ☐ no

5. Lung and Pleura

- Right	- Left
☐ Lung sliding	☐ Lung sliding
☐ A-line	☐ A-line
☐ B-line	☐ B-line
☐ Pleural effusion	☐ Pleural effusion
☐ Alveolar consolidation	☐ Alveolar consolidation
☐ Lung point	☐ Lung point
☐ others	☐ others

6. IVC diameter: cm

7. other findings

Ultrasonography for ECMO & RRT

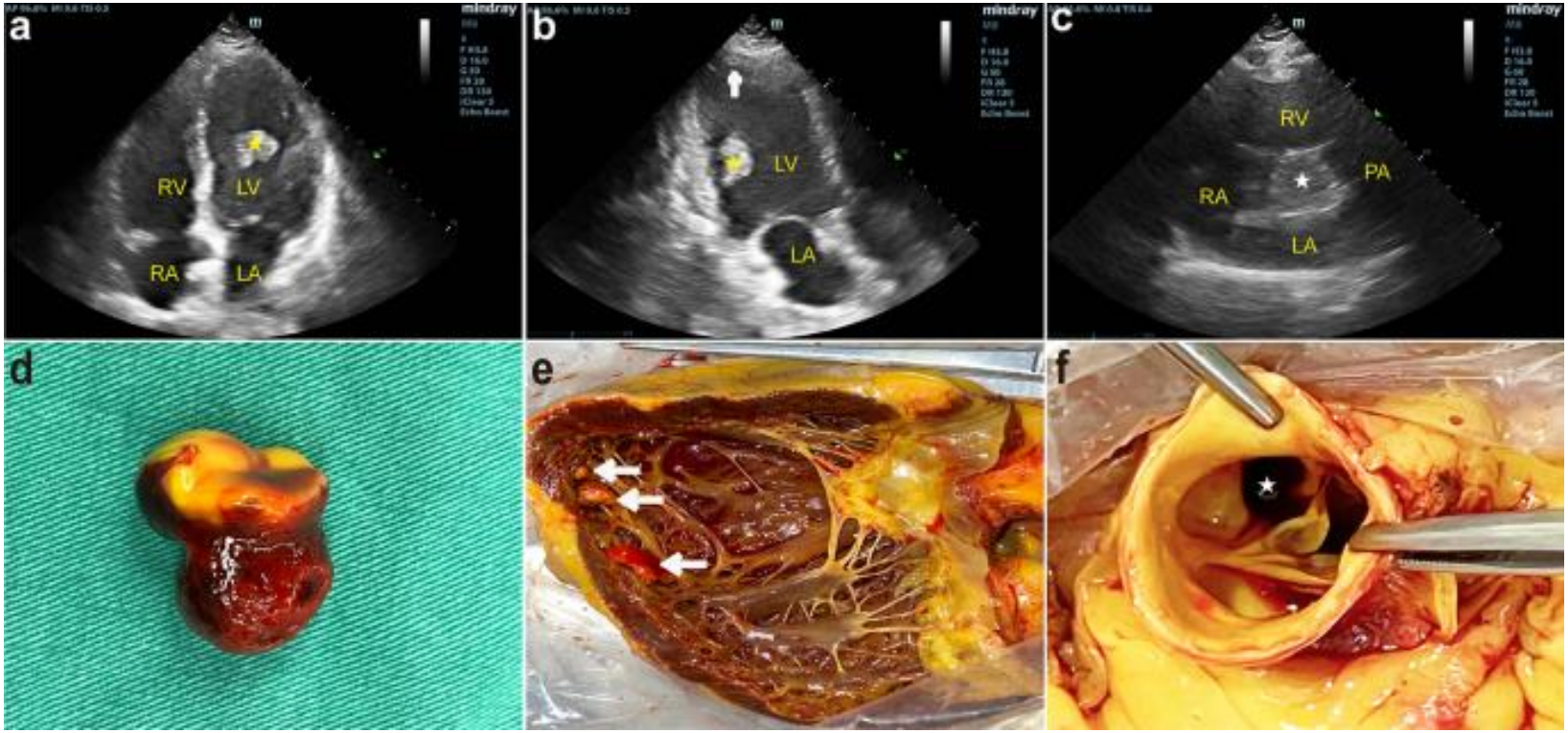
- Monitoring for ECMO patients
  - AV opening
  - SEC/LV thrombus
  - pericardial hematoma
  - cannula reposition

- Monitoring for RRT
  - IVC diameter : RA pressure, fluid responsiveness

VA−ECMO : Afterload ↑

- Not always problematic
- Ejection pressure needed for AV opening ↑
  - inadequate LV systolic pressure to open AV → loss of native ejection → arterial pulsation ↓ → **retention of blood in LV** & return of blood flow from bronchial circulation → LVEDV & LVEDP ↑

Multiple intracardiac thrombi

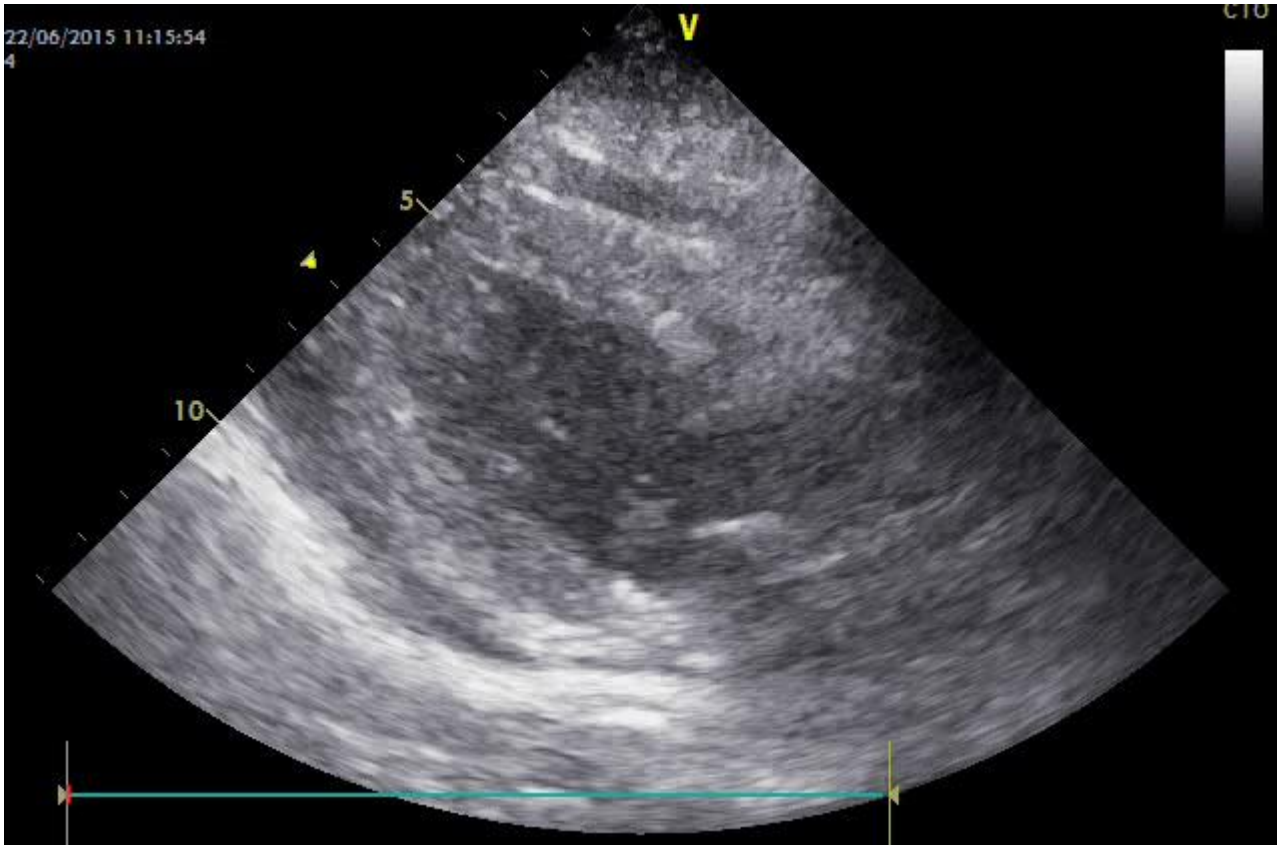


VA−ECMO, TTE, A4C, A3C, and PSAX views, LV thrombi (+)

(Intensive Care Med 49,107–108,2023)

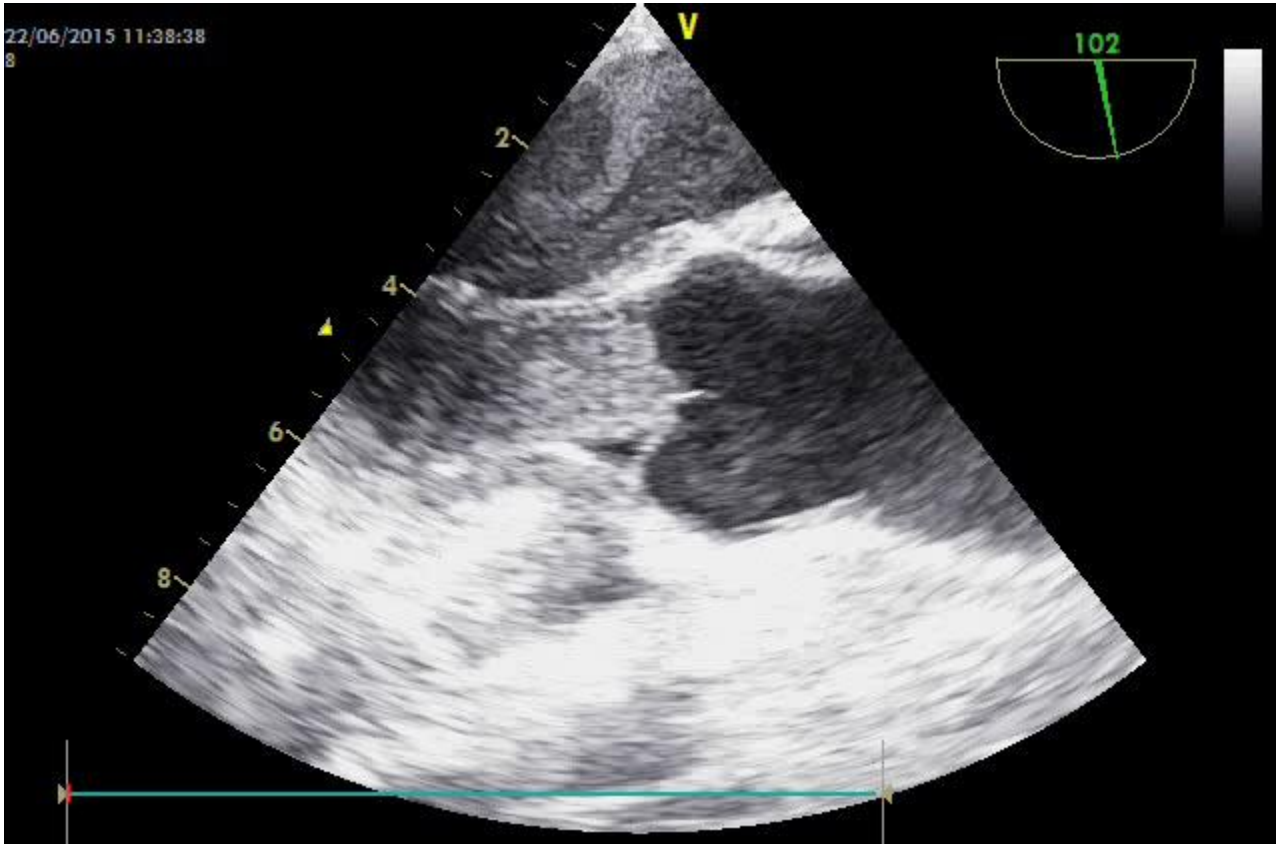
Case

STEMI arrest → ECPR → VA−ECMO insertion



TTE, PLAX view, poor window

Case



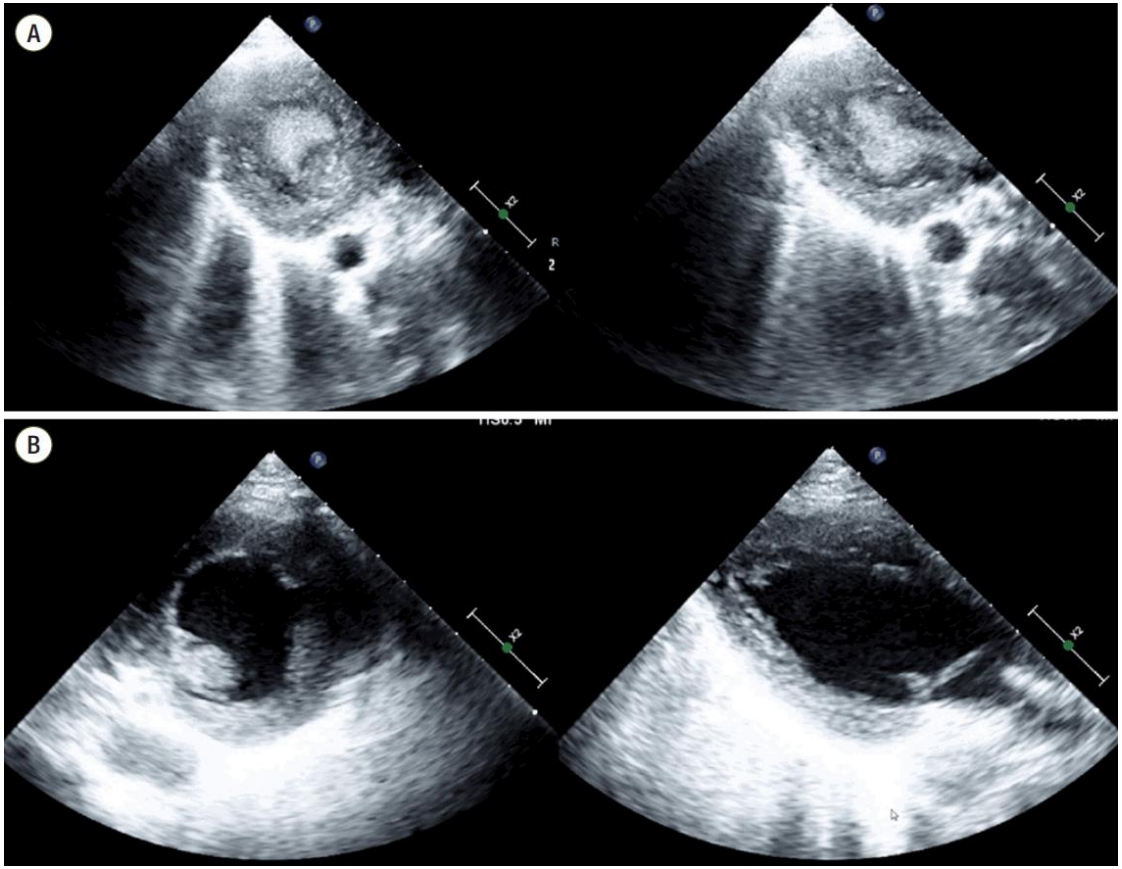
No heparinization, TEE, ME LAX view, LA SEC, LVOT thrombus, AV opening (−)

SEC

- Spontaneous Echocardiographic Contrast
  - smoke-like echo phenomenon with a swirling pattern of blood flow
  - most often within the left atrium
  - caused by increased red blood cell aggregation during low-flow states
  - risk factor of thromboembolism
  - mistaken for a LV thrombus during VA−ECMO

(J Am Coll Cardiol 1991;18:398-404)

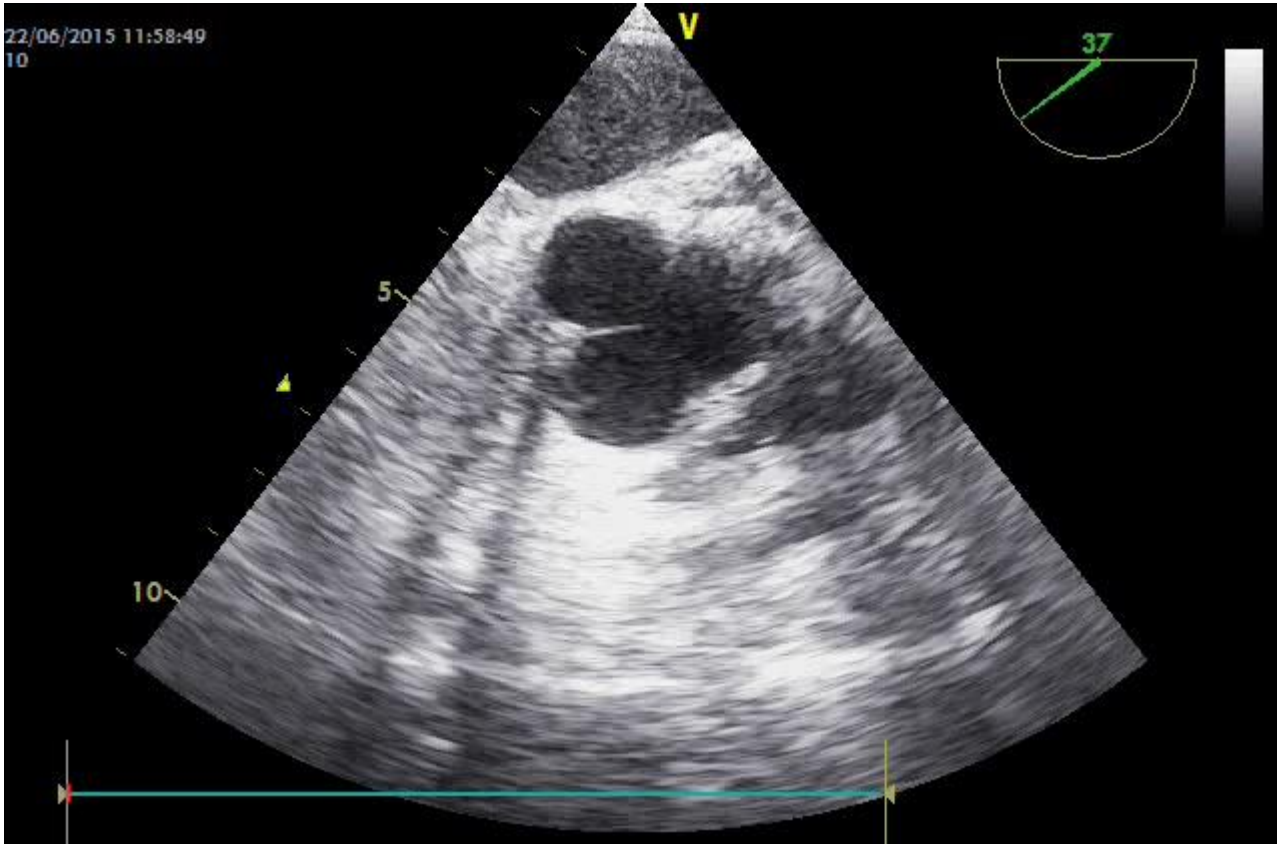
SEC



VA−ECMO, TTE, PSAX & PLAX view, LV SEC, disappeared after volume replacement

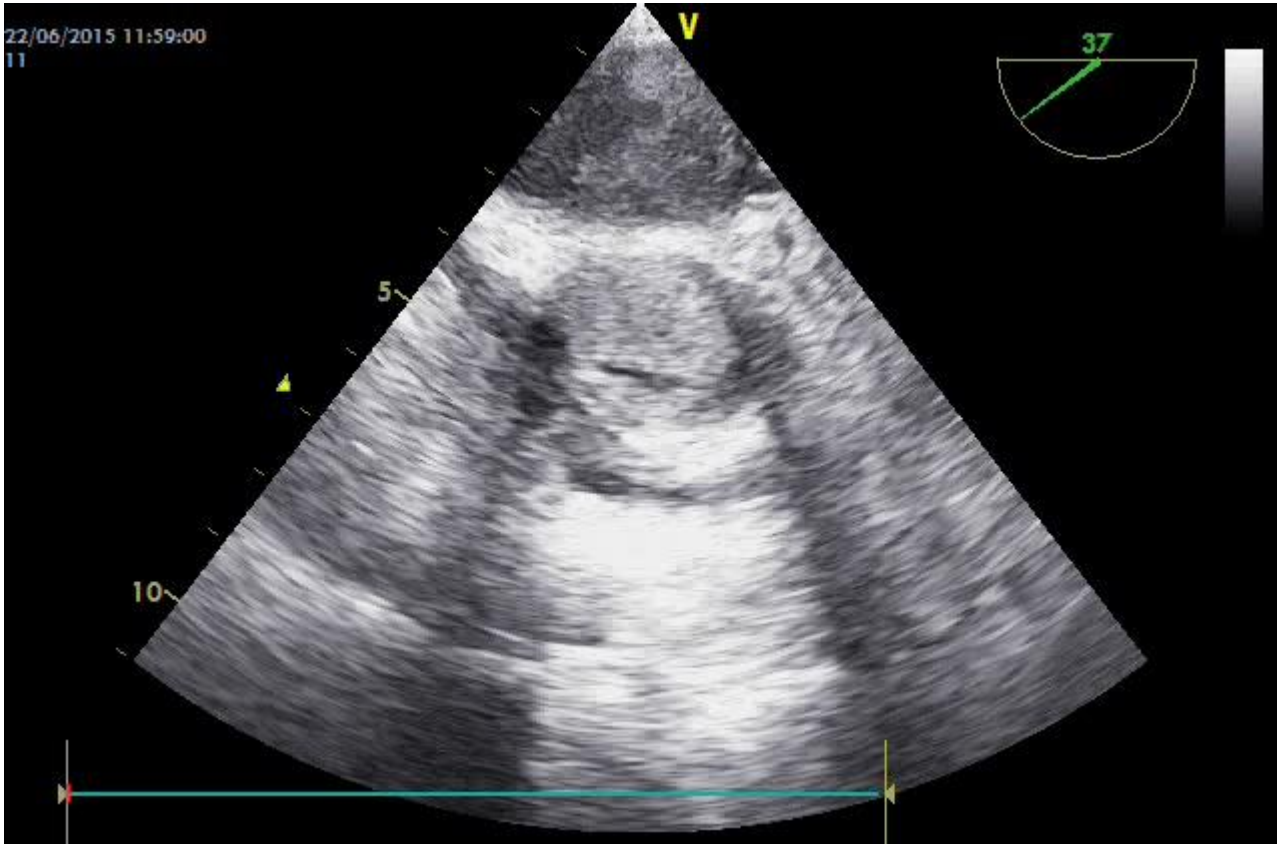
(Korean Journal of Critical Care Medicine 2017;32(4):372-375)

Case



No heparinization, TEE, ME AV SAX view, AV opening (−)

Case



No heparinization, TEE, ME AV SAX view, LVOT thrombus

Case

1day after heparinization, TEE, LVOT thrombus (−), AV opening (+)

VA−ECMO : Afterload ↑

- LVEDP ↑, blood stagnation
  - No established study describing the influence on myocardial contractility in patients on VA−ECMO

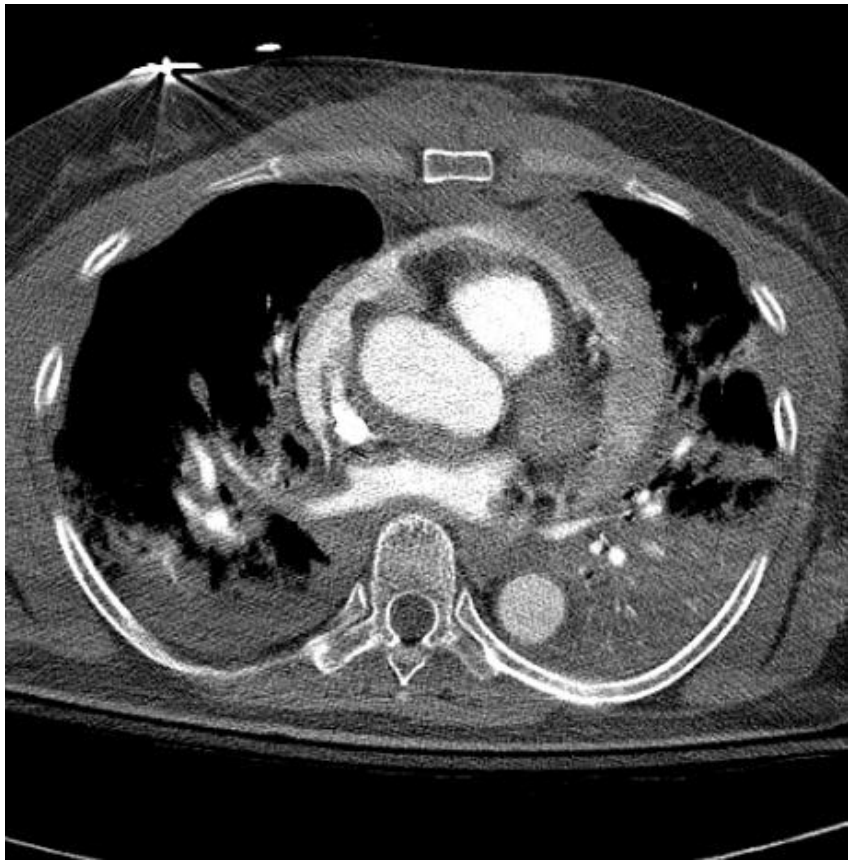
- LV distension requiring decompression
  - No chance for recovery
  - Early detection : most important
    - pulmonary edema : too late
    - **frequently echocardiography : check on AV opening**

Pericardial hematoma

- Especially in ECPR cases
  - one of important causes of failure to be weaned from VA−ECMO

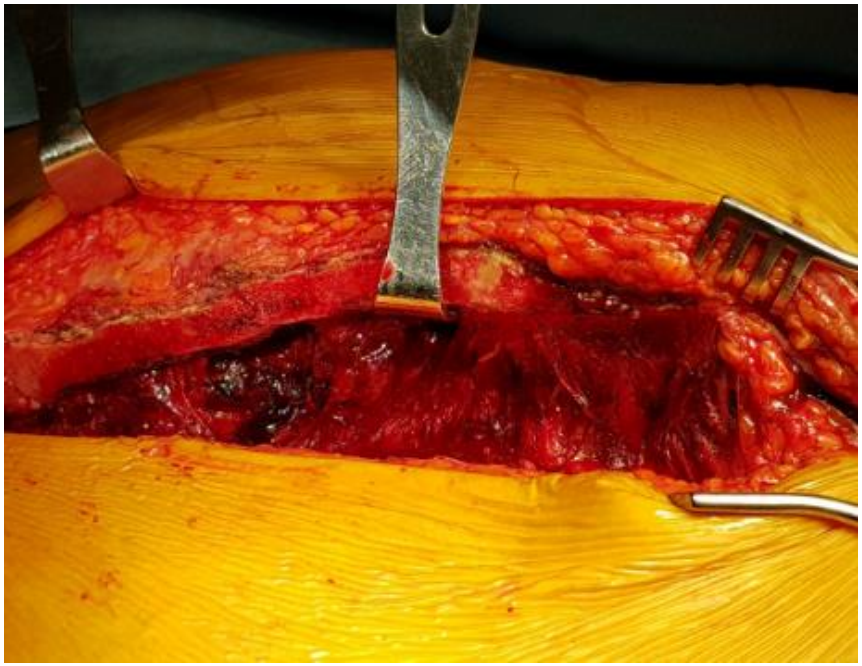
- Early diagnosis
  - prompt decision to perform pericardiocentesis or pericardiostomy

Case 1 : CT angiography

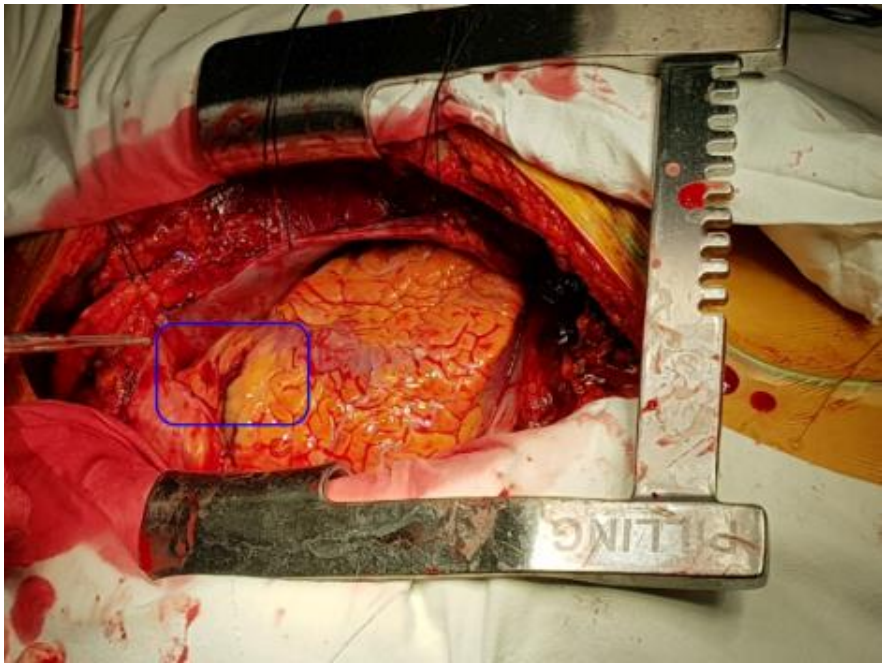


Hemopericardium with contrast enhancement, concerning cardiac tamponade

Case 1 : exploration



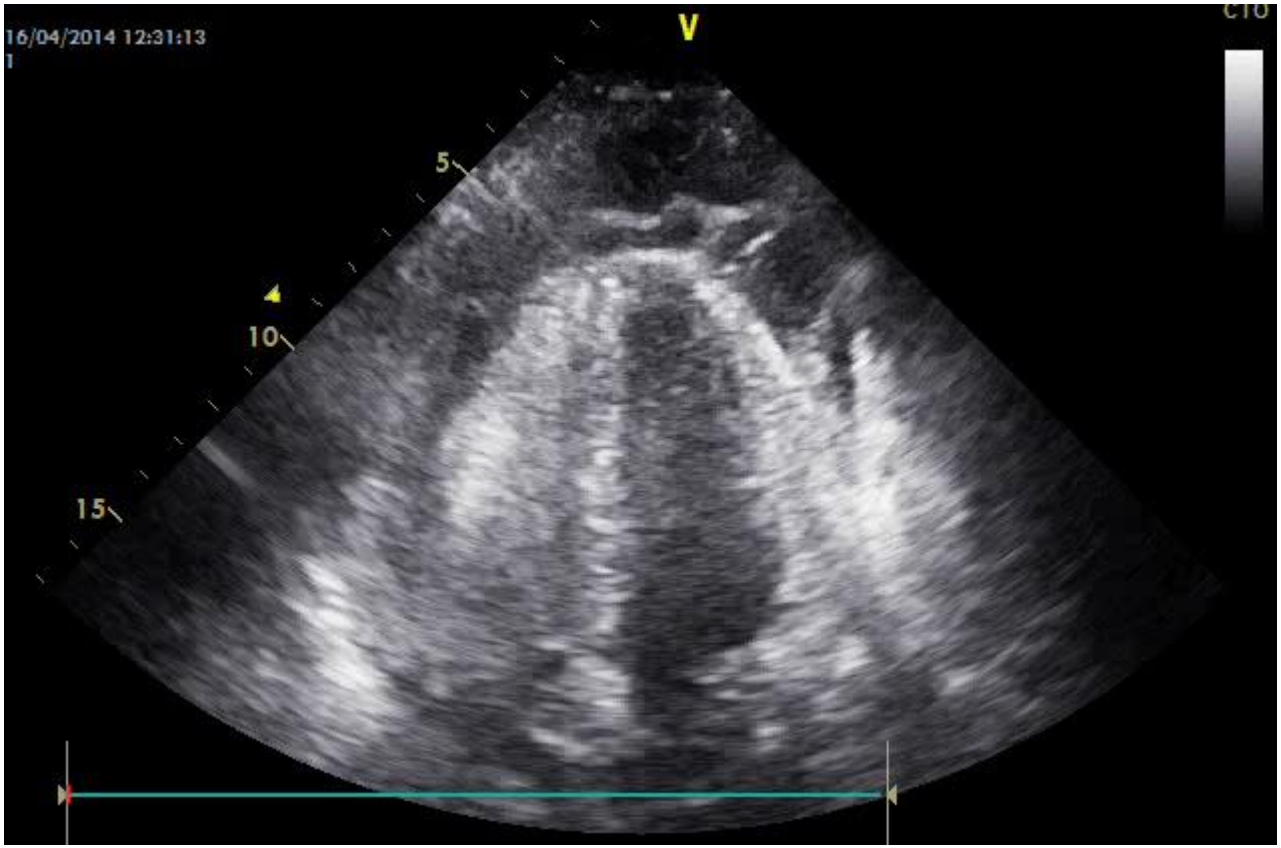
Sternal fracture



Bleeding focus : RCA branch

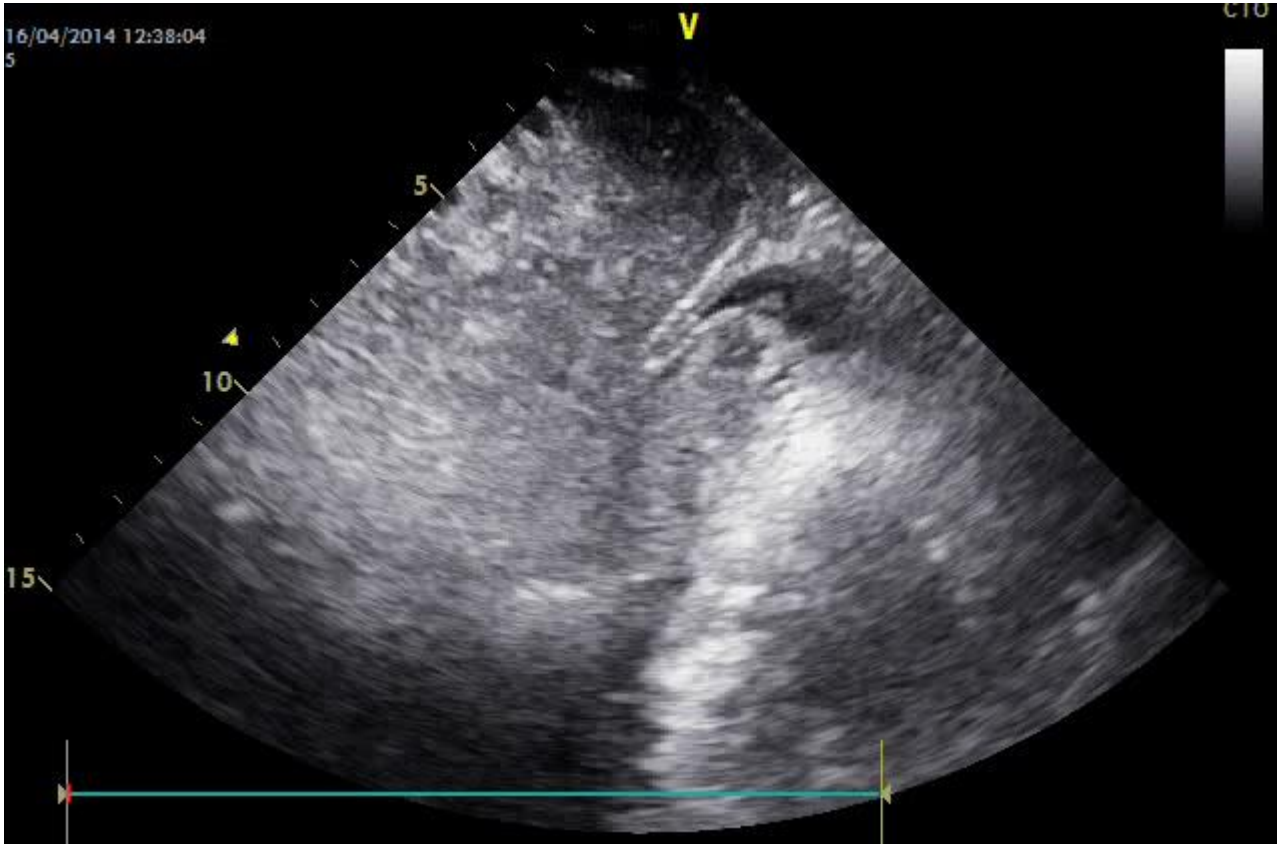
Case 2

NSTEMI arrest → ECPR → VA−ECMO insertion



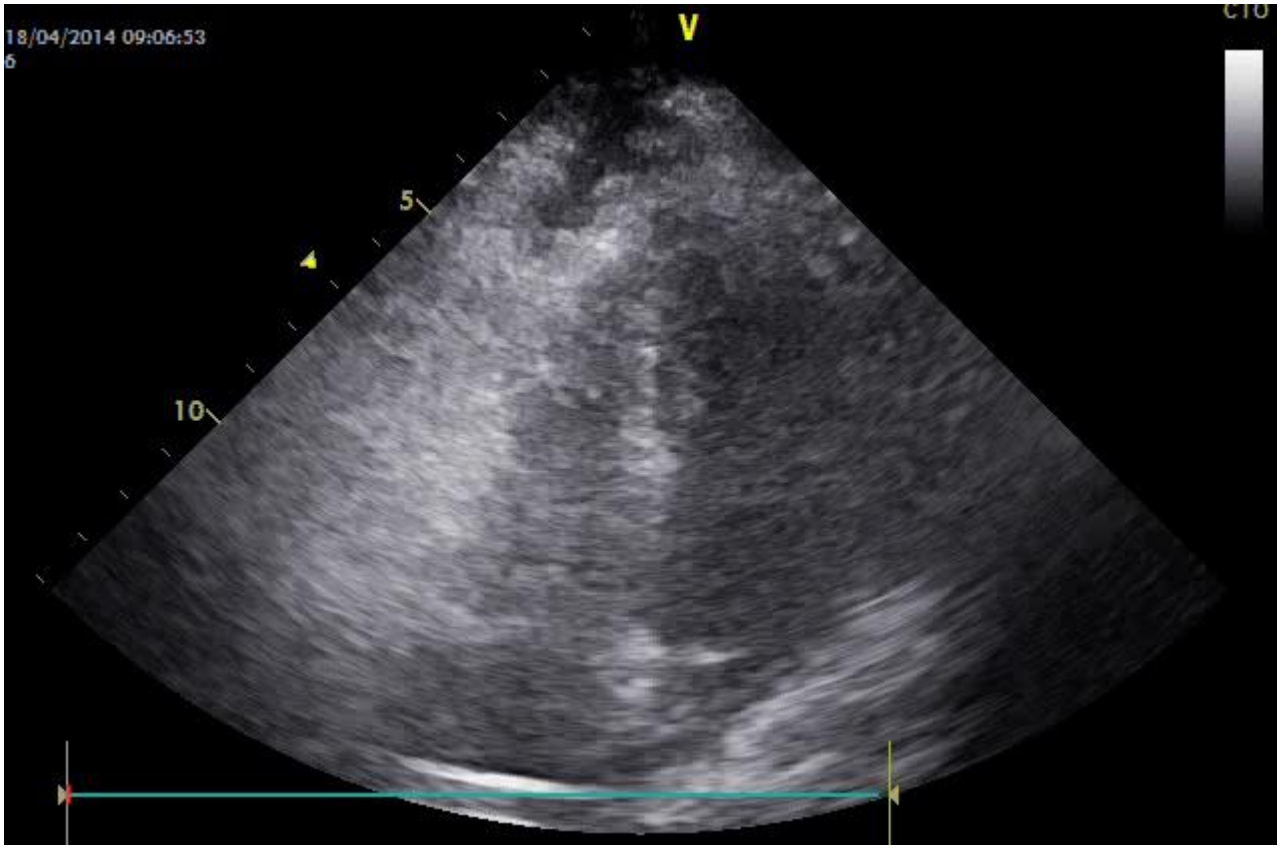
TTE, A4C view, pericardial hematoma, apex

Case 2



TTE, subcostal view, pericardial hematoma, apex

Case 2



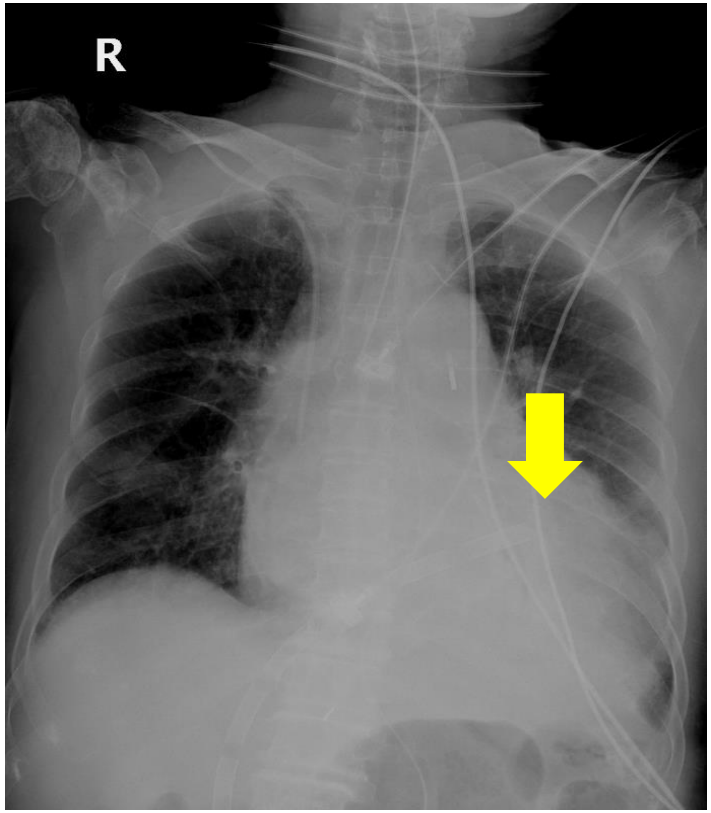
TTE, A4C view, after pericardiostomy

ECMO cannula malposition

- VA−ECMO : venous cannula
- VV−ECMO : inflow cannula
- Blind insertion without fluoroscopy

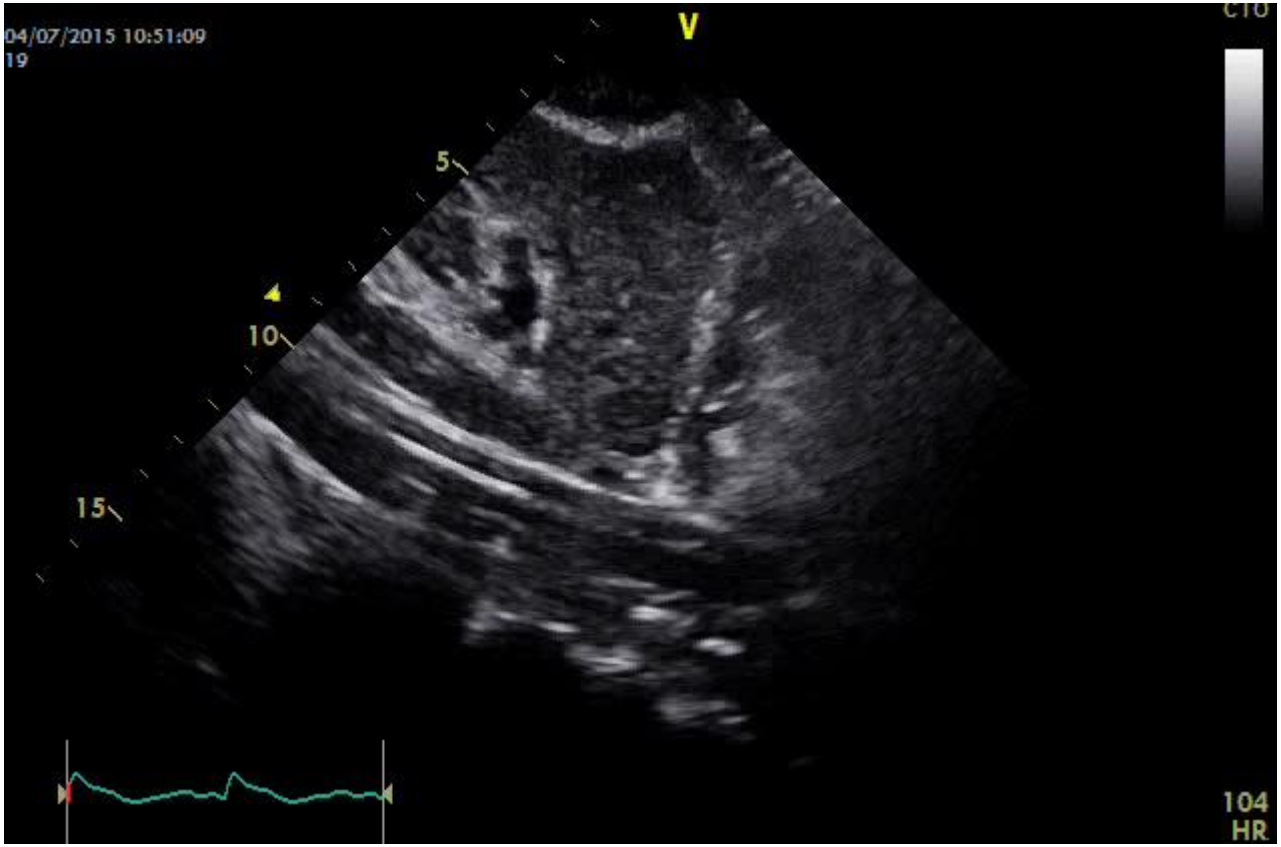
Case

STEMI with postinfarct VSD → cardiogenic shock → VA−ECMO insertion



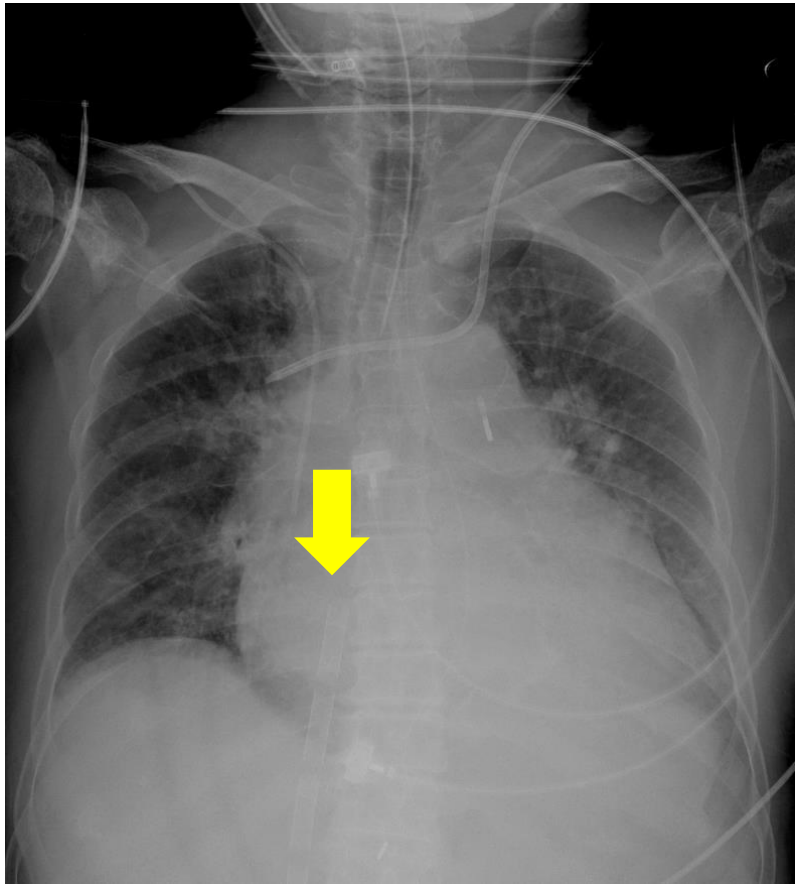
Venous cannula malposition

Case



TTE, subcostal view, venous cannula reposition

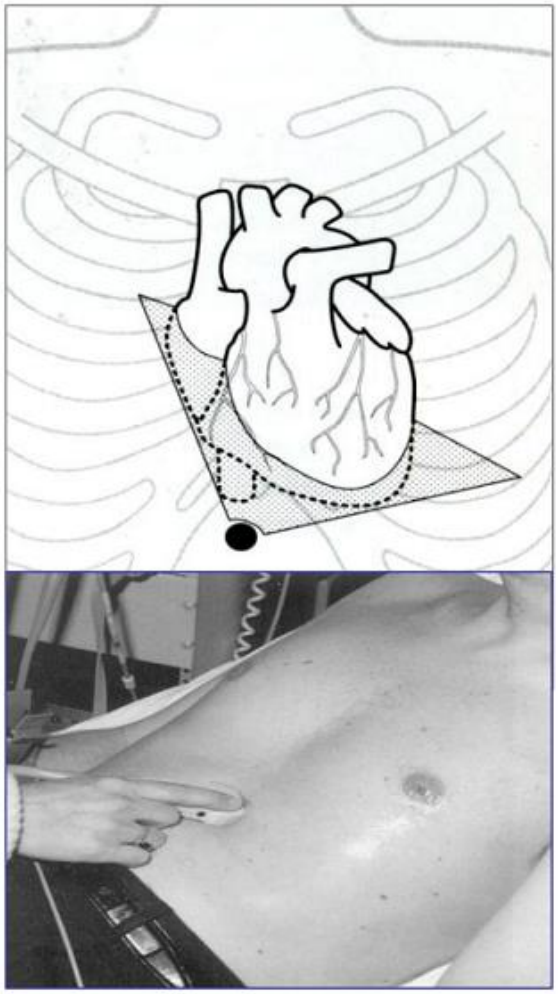
Case

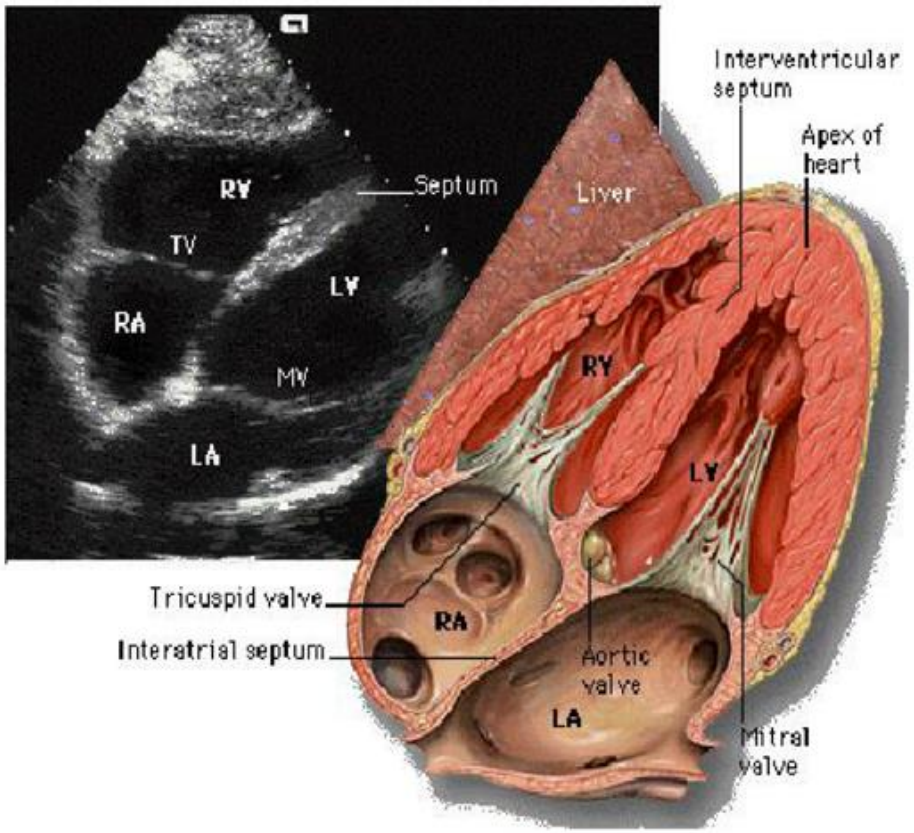


After cannula reposition

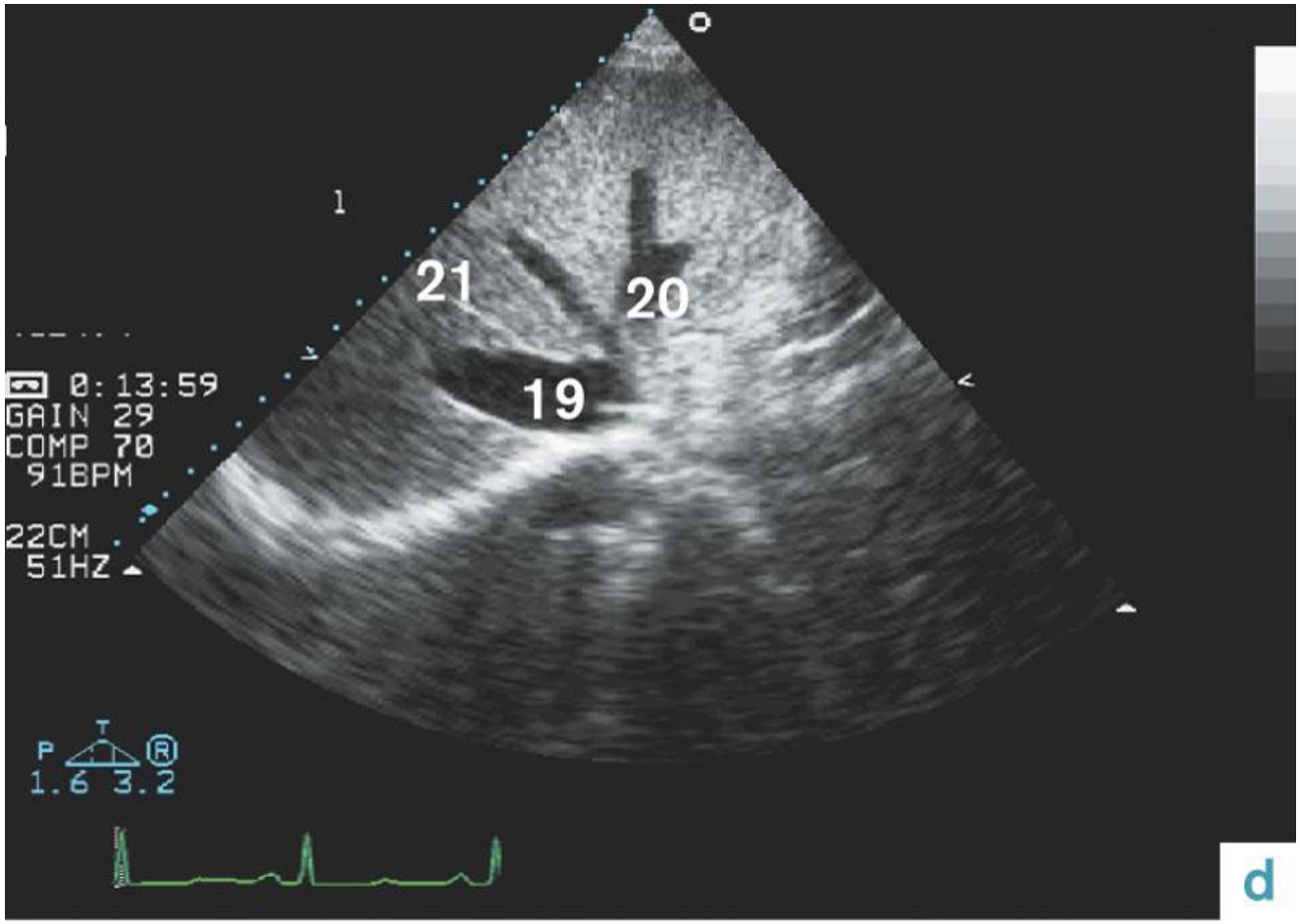
IVC : subcostal view

Subcostal view



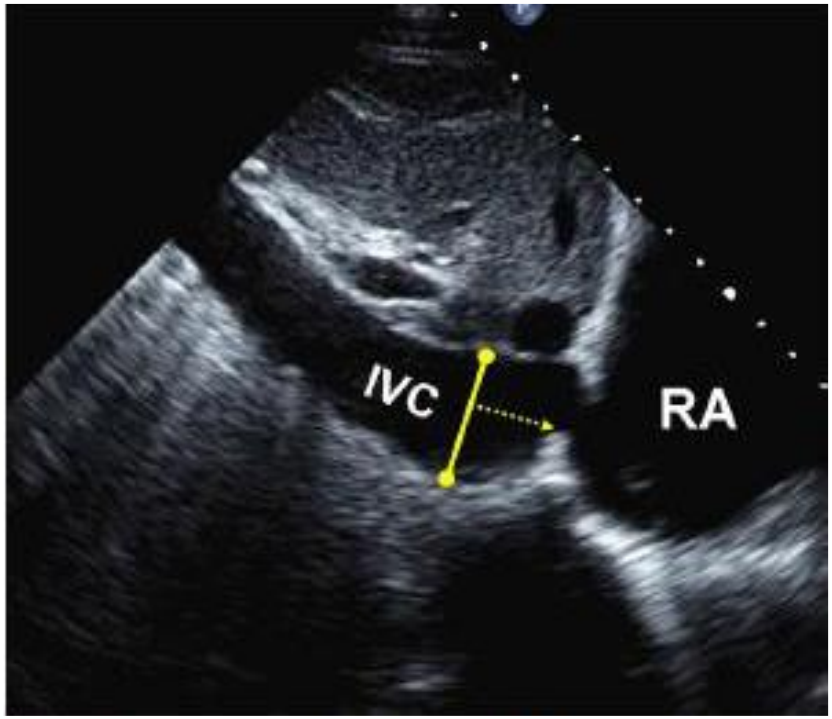


Subcostal view

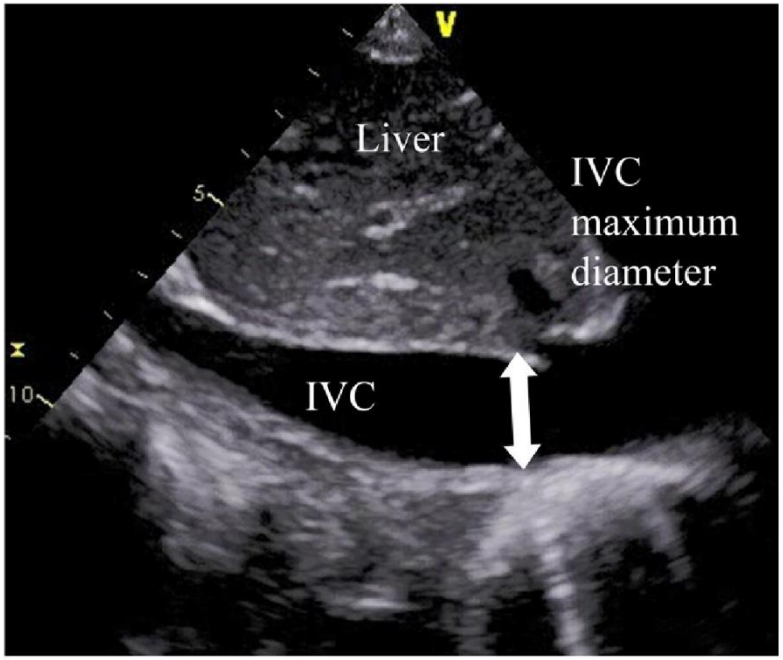


IVC measurement

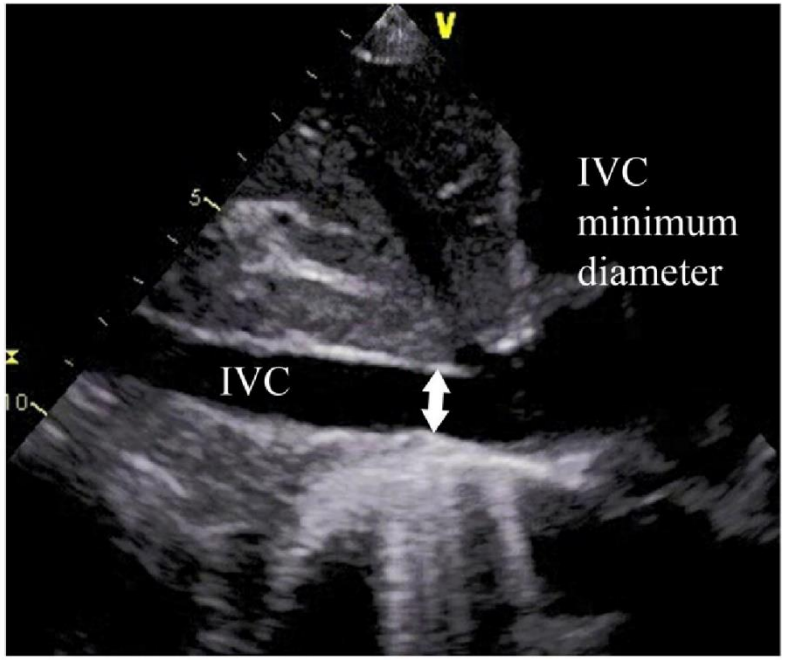
- Subcostal long axis view
- Approximately 0.5 to 3.0 cm proximal to ostium of RA, just proximal to the junction of hepatic veins
- Perpendicular to long axis of IVC at end-expiration



IVC : respiratory variation

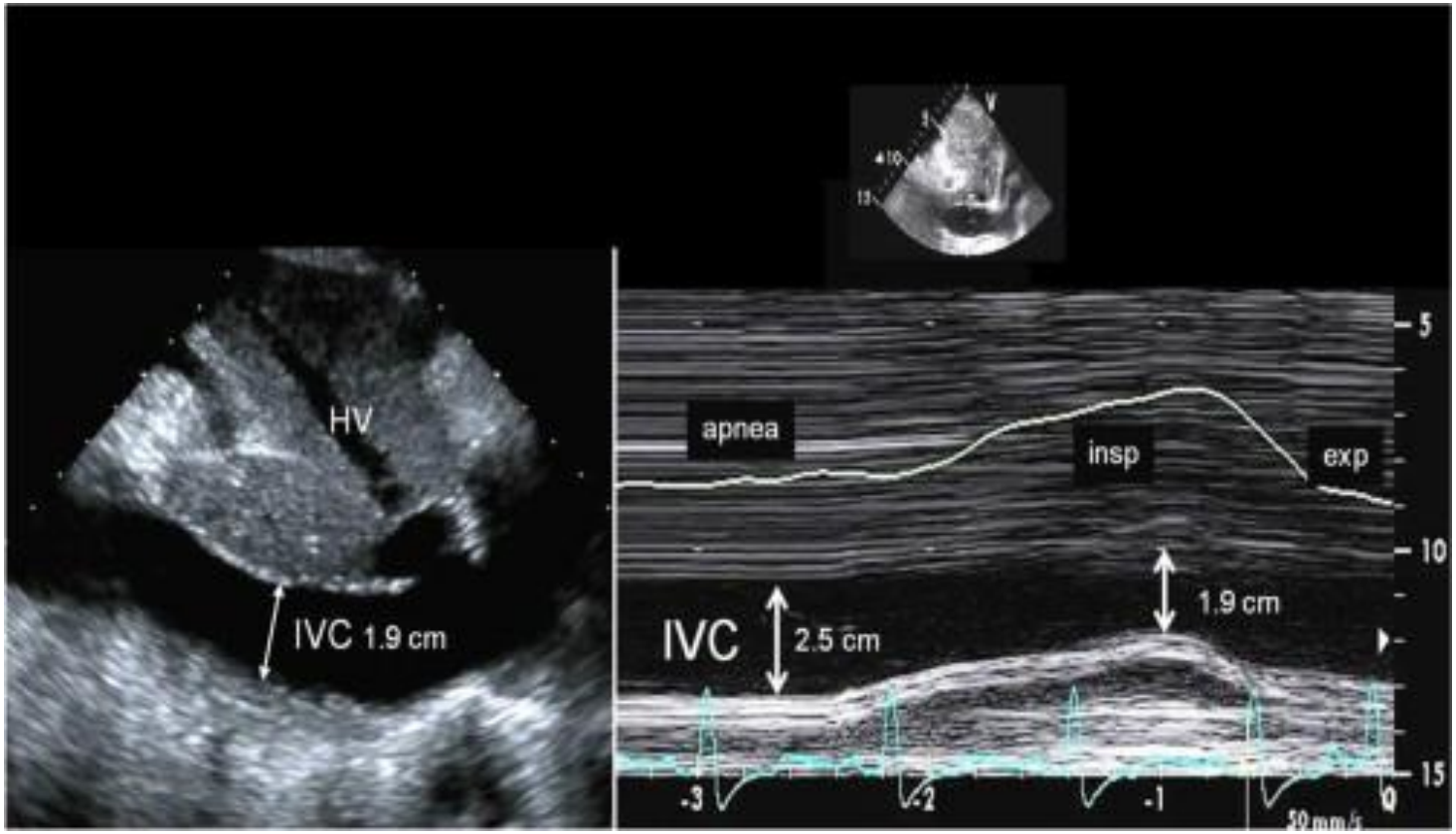


End-expiratory period



After brief sniff

IVC measurement



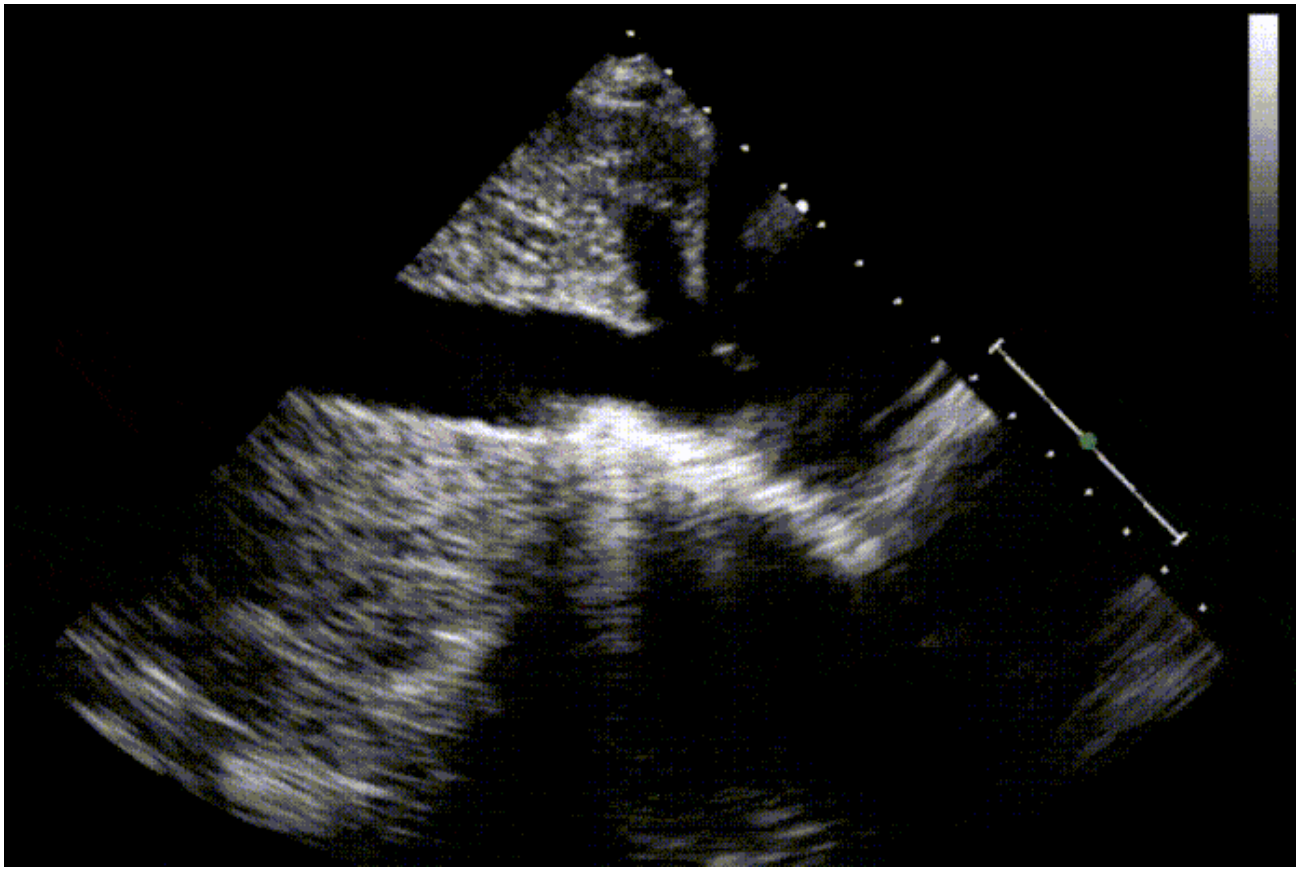
TTE, subcostal long axis view, M-mode

IVC measurement

- RA pressure estimation
  - IVC < 2.1 cm that collapses > 50% with a sniff
    - normal RA pressure of 3 mmHg
  - IVC > 2.1 cm that collapses < 50% with a sniff
    - high RA pressure of 15 mmHg
  - indeterminate cases
    - intermediate RA pressure of 8 mmHg (5-10 mmHg)
  - used in the determination of systolic PAP

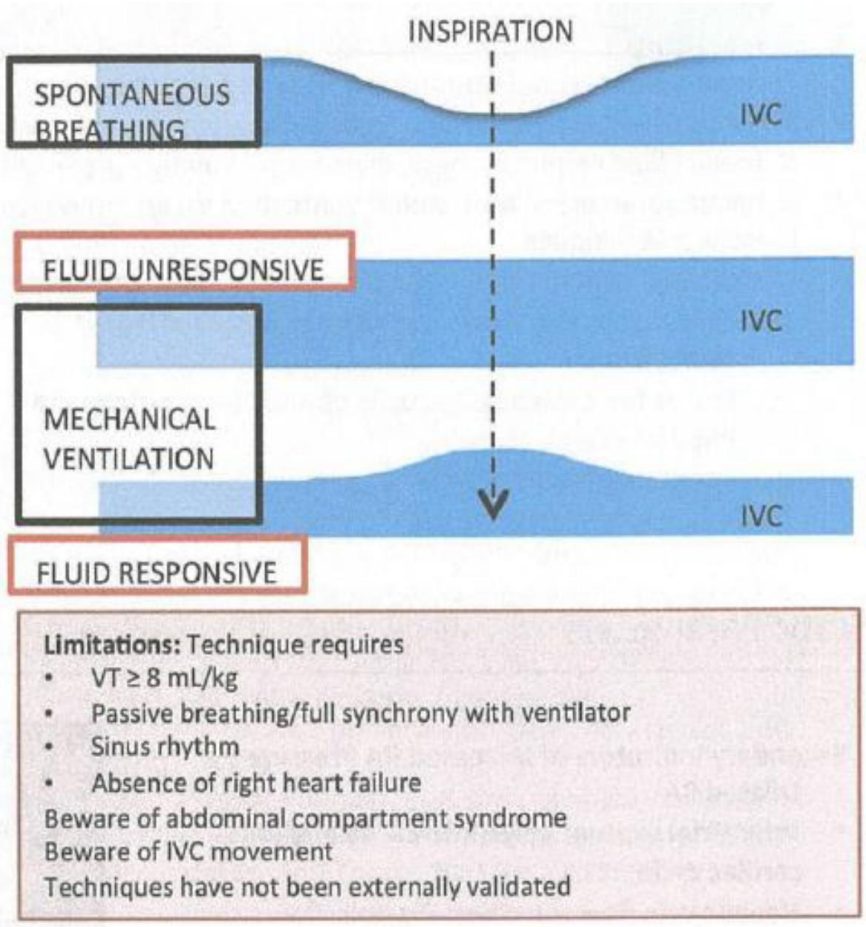
(J Am Soc Echocardiogr 2015;28:1-39)

IVC plethora



Decrease in the IVC diameter by <50% during deep inspiration

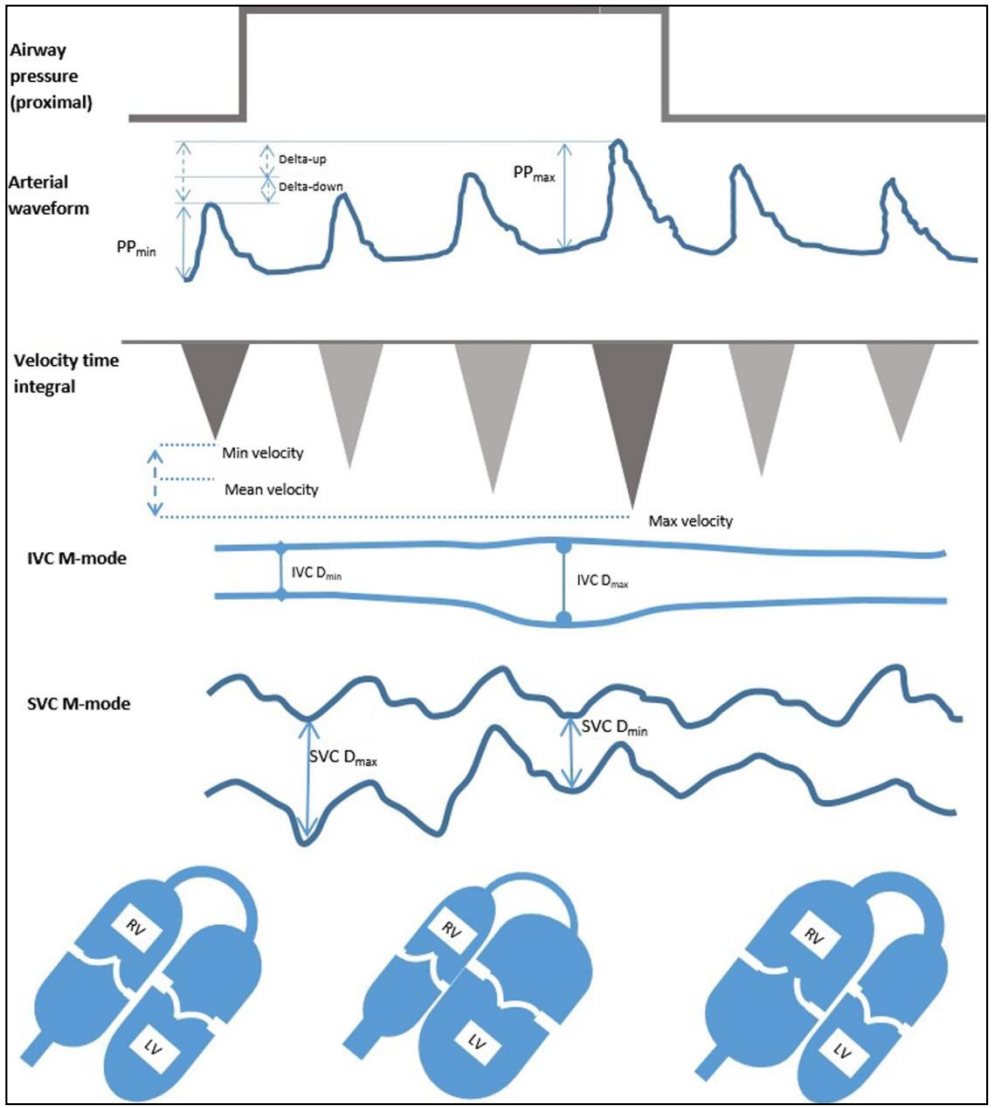
IVC : fluid responsiveness



(J Am Soc Echocardiogr 2015;28:1-39)

Fluid responsiveness

- Prediction of effects of fluid before administration
  - >15% increase in SV in response to volume (500~1000ml/10min)
- Heart–lung interactions
  - respiratory-induced flow & pressure changes
- Inspiratory rise in intrathoracic pressure
  - transmural pressure across RV wall ↑ → RV SV ↓
    - plethora within IVC and compression of SVC
    - venous return ↓, compression of pulmonary vasculature
  - Forcing blood into LV → LV SV ↑ initially
    - ventricular interdependence
    - LV SV ↓ a few heartbeats later



This effect is exaggerated if hypovolemia is present

(Echo Res Pract. 2016 Jun;3(2):G1-G12)

IVC : fluid responsiveness

- Collapsibility index

$$Collapsibility\ IVC = \left(\frac{\text{Dmax} - \text{Dmin}}{\left(\frac{Dmax + \text{Dmin}}{2} \right)} \right) X\ 100$$

  - Volume response is predicted if collapsibility index is > 12%, in spontaneously breathing patients

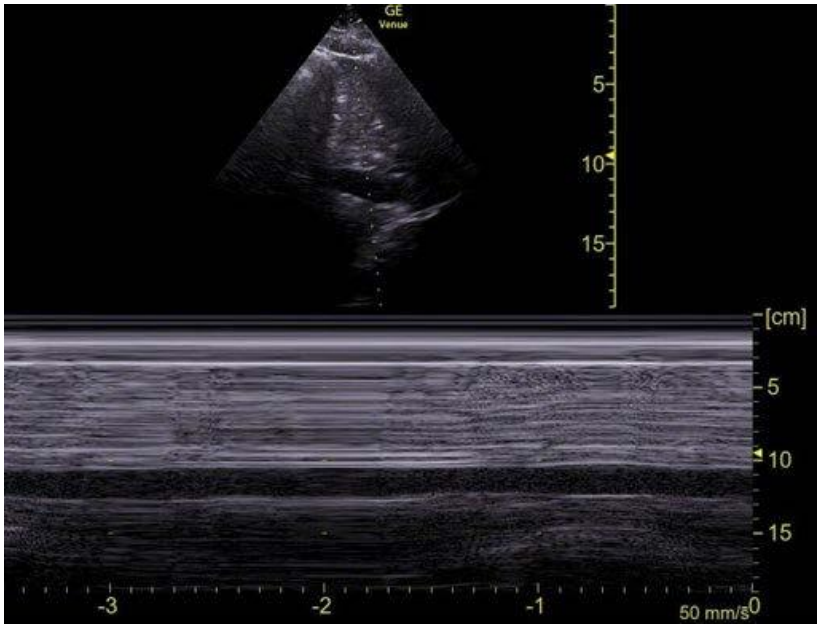
- Distensibility index

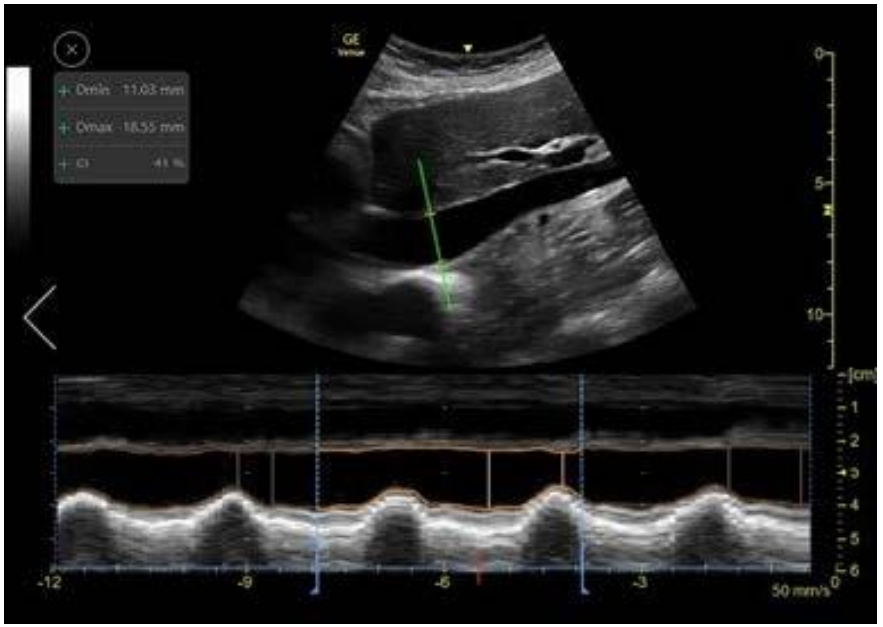
$$Distensiblity\ IVC = \left(\frac{\text{Dmax} - \text{Dmin}}{(Dmin)} \right) X\ 100$$

  - Volume response is predicted if distensibility index is > 18%, in mechanically ventilated patients

(Paediatr Anaesth. 2018;28(5):411-4)

IVC automated measurement





- Expert's ability 87% of time for minimal diameters and 92% for maximal diameters
- On average, the difference between IVC tool measurement and expert was < 0.6mm

(Venue Go R2 Technical Product Claims Document. DOC2199650.)

응급 · 중환자 초음파 검사

1. 나952 응급·중환자 초음파 검사는 다음의 요건을 모두 충족한 경우에 인정함.

- 다 음 -

가. 급여대상

쇼크 등 응급상황의 원인 감별, 급성 병변 판정, 치료 방침 결정, 처치·시술 시 보조(천자 및 카테터 삽입 시) 등 빠른 의사결정 및 정확하고 안전한 처치를 위해 초음파 검사가 필요한 환자

나. 산정요건

나952 응급·중환자 초음파는 초음파 장비가 설치된 중환자실이나 응급실*에서 의사가 직접 시행하고 검사결과 등을 진료기록부에 기재하는 것을 원칙으로 함. 다만, 나952나 복합 표적 초음파는 응급상황이 발생하여 해당 요양기관의 응급실이나 중환자실 이외 장소에서 검사한 경우에도 인정함.

*「응급의료에 관한 법률」에 의한 응급의료기관의 응급실

다. 산정방법

1) 나952가 단일 표적 초음파의 검사부위는 ①두경부, ②흉부, ③심장, ④복부(비뇨기계 포함), ⑤남성생식기 또는 여성생식기, ⑥사지로 분류되며, 검사범위에 따라 1부위 또는 2부위 이상으로 구분하여 산정함(각 부위별 근골격, 혈관, 신경 등은 해당 부위에 포함).

2) 나952나 복합 표적 초음파 검사는 아래의 조건을 모두 충족한 경우에 산정하며, 이를 충족하지 않는 경우 상기 1)에 따라 나952가 단일 표적 초음파 검사를 산정함.

- 아 래 -

(가) 적응증

급성 흉부·복부·골반 외상, 심정지, 쇼크나 불안정한 혈류역학, 호흡곤란, 흉통

(나) 실시인력

응급의학과 전문의(전공의), 외과계 전문의(외상외과 분야에 한함), 중환자실 전담의

(다) 검사범위

흉부, 심장, 복부골반을 모두 포함하여 검사해야 하며, 필요 시 두경부, 사지 등을 추가 검사한 경우

Summary

- Monitoring for ECMO patients
  - AV opening
  - SEC/LV thrombus
  - pericardial hematoma
  - cannula reposition

- Monitoring for RRT
  - IVC diameter : RA pressure, fluid responsiveness

부천세종병원

Thank you for your attention !