

# **폐혈관 School 2014: Case study (PAH)**

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**서울아산병원**  
**Asan Medical Center**



**Center**  
Pulmonary Hypertension & Venous Thrombosis Center  
폐고혈압·정맥혈전센터

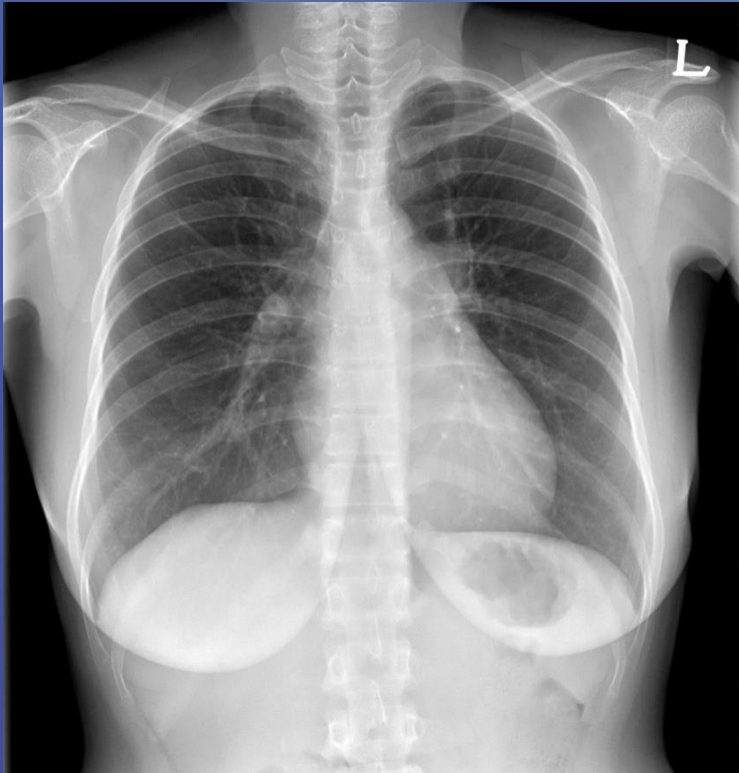
# Case presentation

- IPAH: CCB responder  
CCB nonresponder; IV & SQ treprostinil
- SLE-PAH
- CHD-PAH : Heart-lung transplantation
- “Out-of proportionate” PH in Left heart disease
- CTEPH : pulmonary thromboendarterectomy
- PH associated with pulmonary artery stenosis
- PH associated with pulmonary vein stenosis



# Case 1 (F/40)

- C. C. : Dyspnea ( WHO Fc II)
- P. M. Hx (-)
- Initial CXR & EKG:

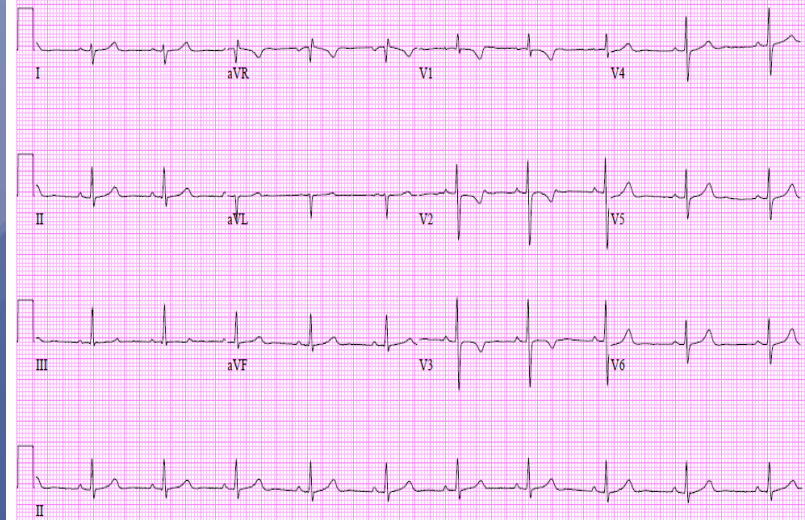


40 yr	Vent. rate	61	BPM	Normal sinus rhythm
Female	PR interval	148	ms	Right ventricular hypertrophy with repolarization abnormality
	QRS duration	84	ms	Abnormal ECG
Room: W1	QT/QTc	420/422	ms	
Loc: 23	P-R-T axes	54 105 49		

Technician: SYJ  
Test ind: 107870

Referred by: 123W PLM

Confirmed By: GI BYOUNG NAM



# Case 1 (F/40)

Lab.: CBC 6400-13.5-237K

BUN/Cr 11/0.7 mg/dL AST/ALT 22/14 IU/L T.B 0.8 mg/dL

HBsAg/Ab (-/-) HCV-Ab(-) **BNP 34 pg/mL**

**FANA (-) RF factor (-) ANCA (-)**

**TSH/free T4 W.N.L**

Echo : LVEF 70%, E/E' 11, **D-shape LV**

**TR Vmax 4.2 m/s, PG(RV-RA) 71 mmHg**

**RV free wall thickness 8mm, mPA 27mm**

-> severe resting PH with severe RV dysfunction

No intracardiac shunt

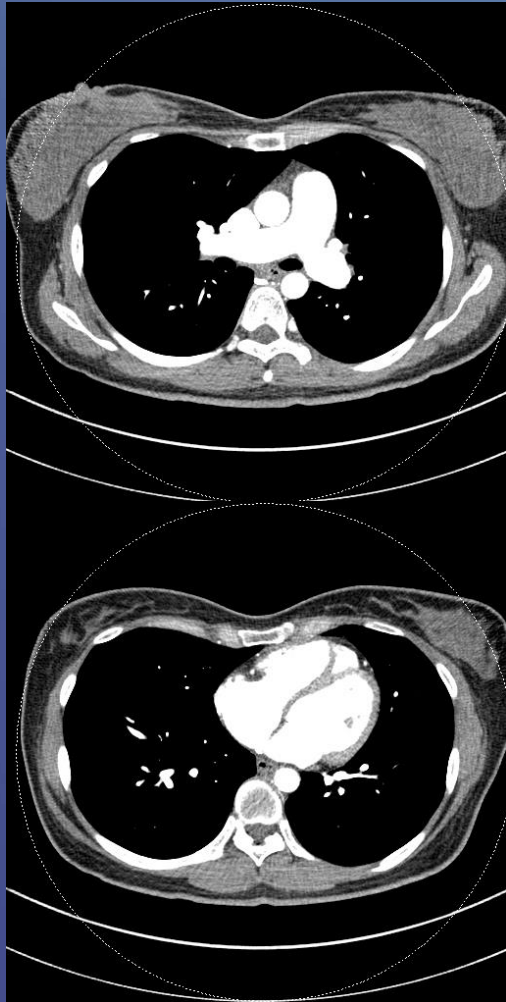
PFT: FEV1/FVC 79% FEV1 90% pred. FVC 97% pred.

DLco 75 % pred. DL/VA 82% pred.

6MWD 500m (SaO2 98%)



# Case 1; CT, pulmonary embolism



# Case 1; Perfusion scan

Patient Name: KIM, SOOHEE, F40  
Study Date: 7/5/2011

Patient ID: 42187196

Study Name: Lung^Perfusion Scan

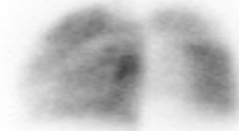
Lung Perfusion Scan  
99mTc-MAA



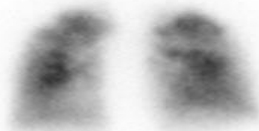
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LAO



LPO



POST



RPO



RAO

Medium to large perfusion defects in BUL



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# Case 1; RHC & acute vasodilator test

	Baseline	NO 10ppm	NO 20ppm		Peridipine 1.5mg
BP	121/68	118/64	124/74		97/52
sPAP/dPAP	<b>69/28</b>	<b>28/9</b>	<b>16/8</b>		<b>40/12</b>
Mean PAP	<b>43</b>	<b>17</b>	<b>12</b>		<b>24</b>
PCWP	2	2	2		2
CO	<b>3.7</b>	<b>3.5</b>	<b>3.9</b>		<b>3.8</b>
HR	71	60	69		82
PVR	<b>886</b>	<b>366</b>	<b>246</b>		<b>484</b>



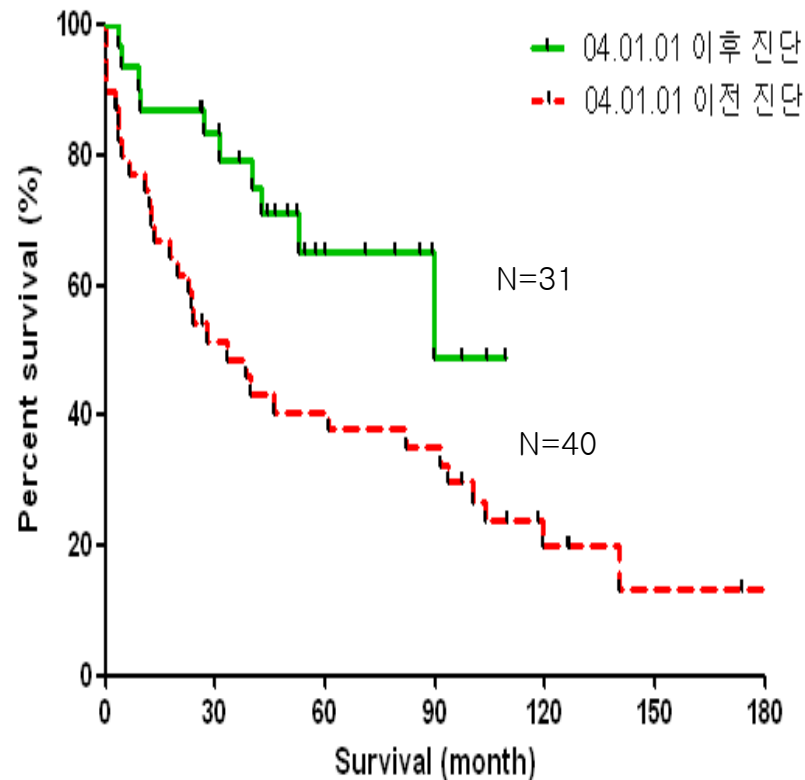
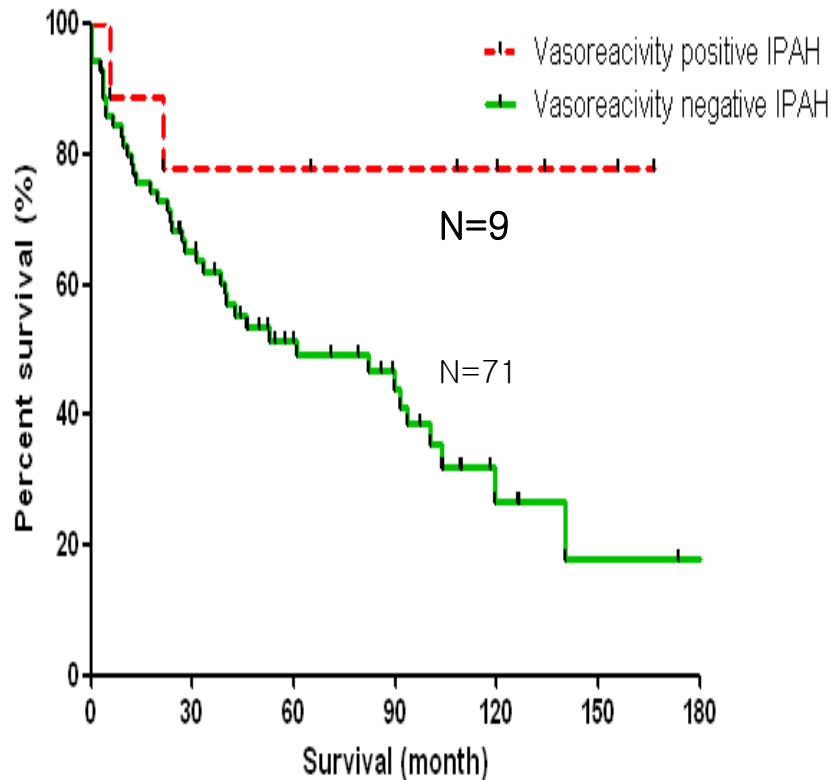
# Case 1; Diagnosis & treatment

- Dx: **IPAH, CCB responder**
- Tx: **nifedipine 30mg qd**
  
- 3 Month f/u
  - Dyspnea (-)
  - Echo: **TR Vmax 2.2m/s, PG 19 mmHg**  
**normalized RV contractility**
  
- 3 year f/u with nifedipine 30mg qd without deterioration.



# Survival of IPAH patients in AMC

Survival of Data 1: Survival proportions

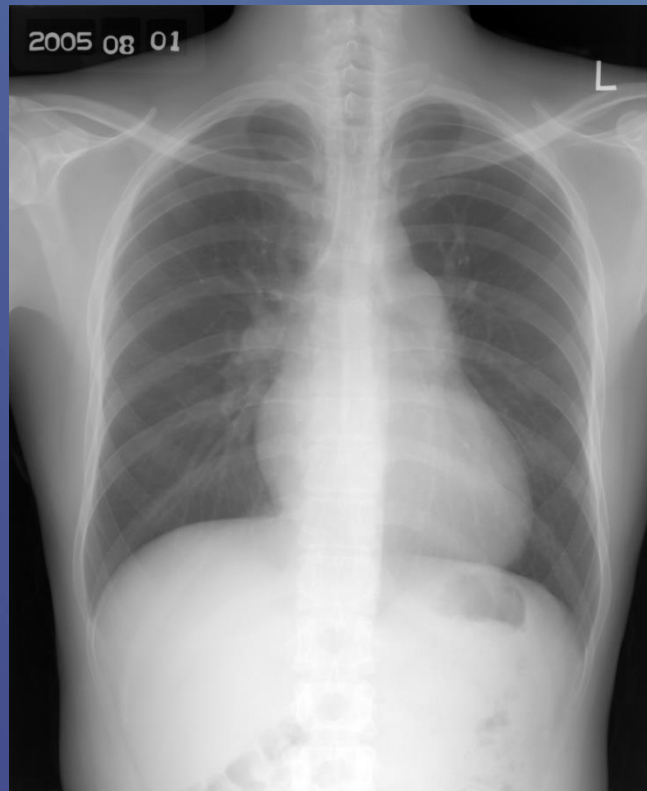


# Characteristics of acute vasoreactivity positive IPAH patients

	All Patients (n=60)	Acute Responders (n=9)	Non- Responders (n=51)	P Value
Age at diagnosis, yr	33±13	38±16	32±13	0.355*
Onset of symptoms, mo	35±46	39±40	34±47	0.858*
WHO functional class I:II:III:IV, %	3:32:60:5	11:44:44:0	2:29:63:6	0.085‡
Six-minute walk distance, m	413±137	460±147	404±135	0.077*
<b>Peak velocity of TR, m/sec</b>	<b>4.5±0.6</b>	<b>4.1±0.3</b>	<b>4.6±0.6</b>	<b>0.01*</b>
Mean RAP, mm Hg	8±5 (n=30)	6±4 (n=8)	8±6 (n=22)	0.237*
<b>Mean PAP, mm Hg</b>	<b>61±17</b>	<b>47±10</b>	<b>63±17</b>	<b>0.003*</b>
Cardiac output, L/min	4.0±1.4 (n=57)	4.7±2.6	3.9±1.1 (n=48)	0.632*
PVR, Wood units	13.8±7.5 (n=41)	10.3±4.9	14.7±7.9 (n=32)	0.154*
SvO <sub>2</sub> , %	67±9 (n=46)	70±5 (n=8)	66±9 (n=38)	0.191*

# Case 2 (M/31)

- C. C : Dyspnea ( WHO Fc III)
- P/Ex: both leg pretibial pitting edema
- Initial CXR & CT:



Echo : **TR Vmax 5.1 m/s, PG(RV-RA) 104 mmHg**

-> severe resting PH with severe RV dysfunction

PFT: FEV1/FVC 85% FEV1 88% pred. FVC 83% pred.

DLco 82 % pred.

6MWD 537m (SaO<sub>2</sub> 96%)

RHC: **sPAP/dPAP/mPAP 93/54/66 mmHg PCWP 13 mmHg**

**CO 3.2 L/m (CI 2.0) ( Non-responder to NO)**

**Assessment: IPAH**

Treatment : **sildenafil 25mg tid, inhaled iloprost**



# 7 years after combination treatment with sildenafil and iloprost

S: dyspnea (Fc IV)

O: both pretibial pitting edema

BUN/Cr 21/1.59 mg/dL

AST/ALT 35/20 IU/L

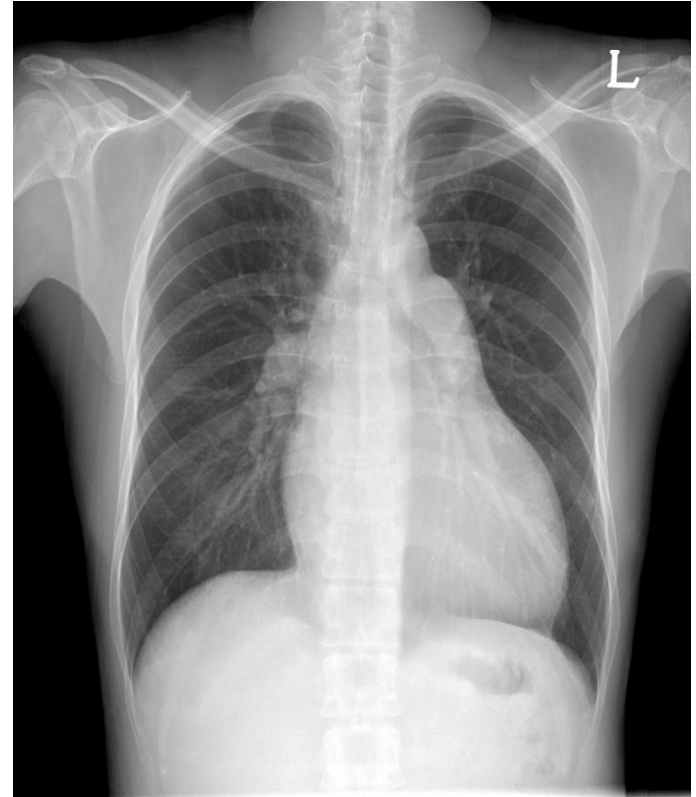
T. B 3.5 mg/dL

BNP 1247 pg/mL

6MWD 335m (95%)

Echo: TR Vmax 5.4m/s

PGsys(RV-RA) 117 mmHg



**A: IPAH deterioration with RV failure**

Plan: dobutamine, lasix

**inhaled iloprost -> IV treprostinil 변경**



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# IV treprostinil to SC treprostinil

HD#6 C-line insertion

IV treprostinil 2ng/kg/min start

HD#9 IV treprostinil 14ng/kg/min up-titration

3시간 후

-> **nausea, dyspnea, BP 87/69 mmHg, SaO2 75%**

IV treprostinil 12 ng/kg/min down-titration

→ BP 105/78mmHg, PR 103/m, RR 20/m

HD#12 IV treprostinil 12ng/kg/m

-> SC treprostinil 12ng/kg/m

HD#14 SC treprostinil 20ng/kg/m

HD#18 discharge

Outpatients up-titration 2ng/kg/m per 2 weeks

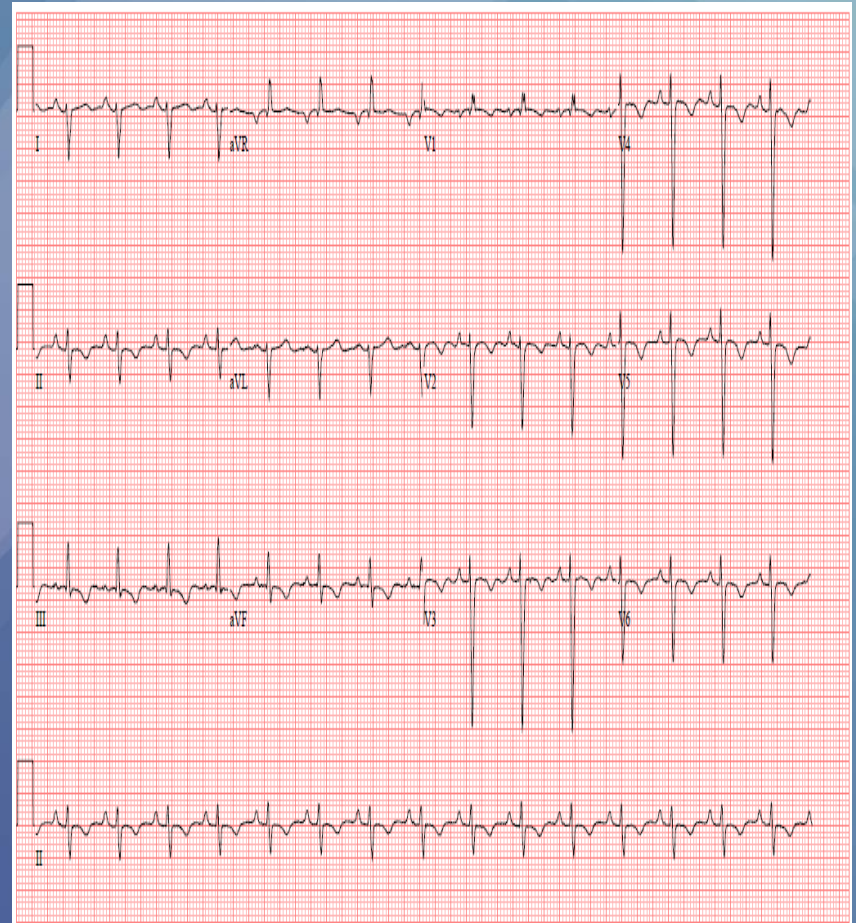
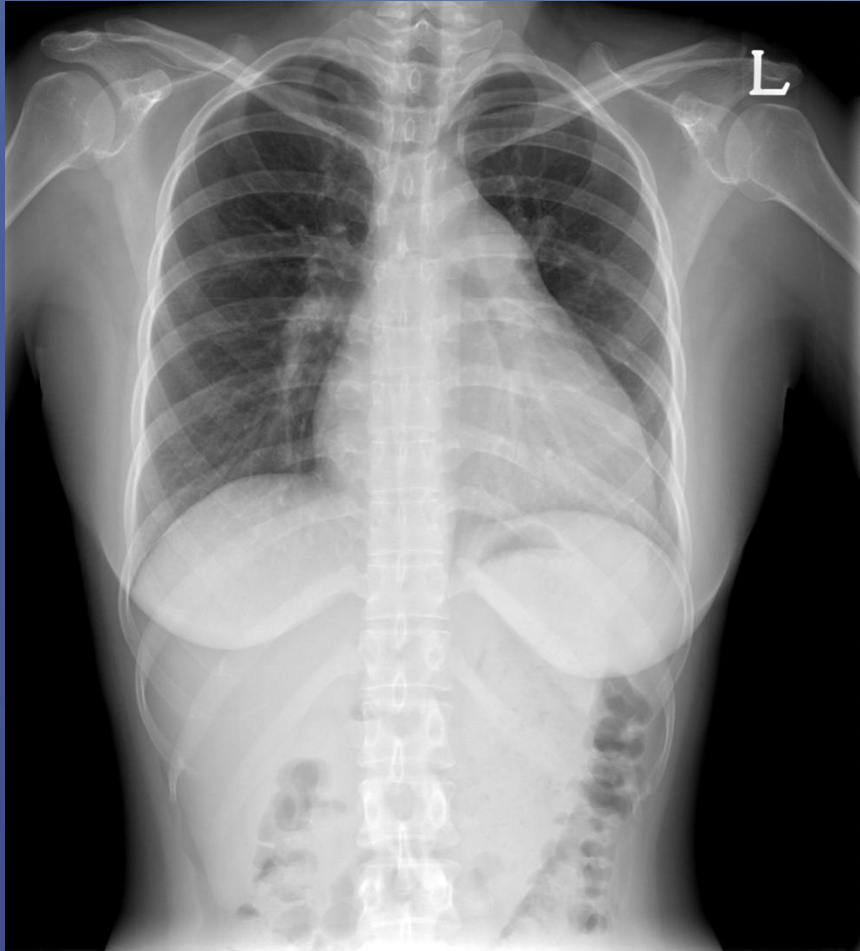
Up to 30ng/kg/min



# Case 3 (F/31)

- C. C : DOE (WHO Fc II) onset; 1 month ago
- P. I: 20YA photosensitivity
  - 8YA polyarthritis (wrist, PIP, MCP) and morning stiffness
  - dry mouth, recurrent oral ulcer
  - 3YA **Raynaud's phenomenon**
- P.M. Hx: **Hypothyroidism**
- R. O. S: cough (-), sputum (-) hemoptysis (-) chest pain (-)
- P/Ex.: BP 104/75 mmHg PR 100/min
  - jugular vein distension (-)
  - RHB without murmur
  - Pretibial pitting edema (-)

# Case 3 (F/31)



# Case 3 (F/31)

Lab.: CBC 5500-15.1-153K  
PT (INR) 1.03 aPTT 23.8s

BUN/Cr 8/0.48 mg/dL Protein/albumin 8.5/3.5 g/dL  
AST/ALT 49/36 IU/L T.B 0.6 mg/dL  
**CRP 1.16 mg/dL ESR 74 mm/hr**  
**BNP 535 pg/mL**

U/A albumin (-) RBC (-) WBC (-)

ABGA 7.46-24-104-18.0-98%

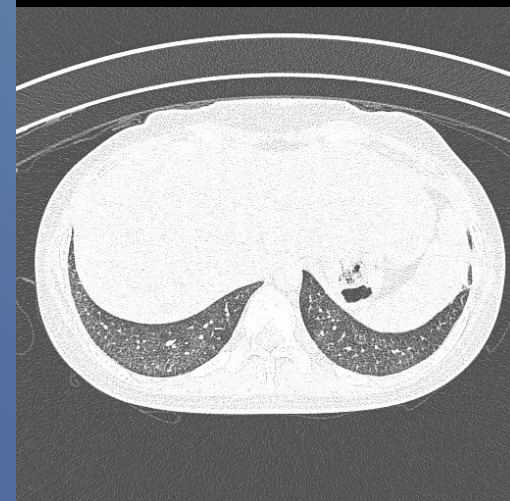
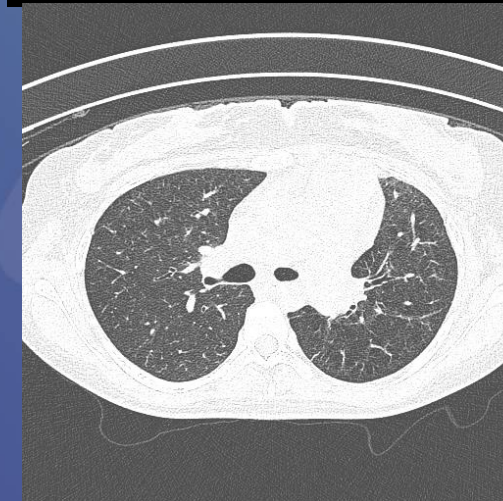
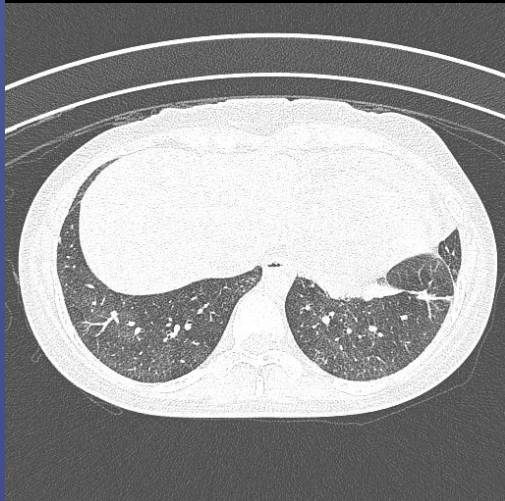
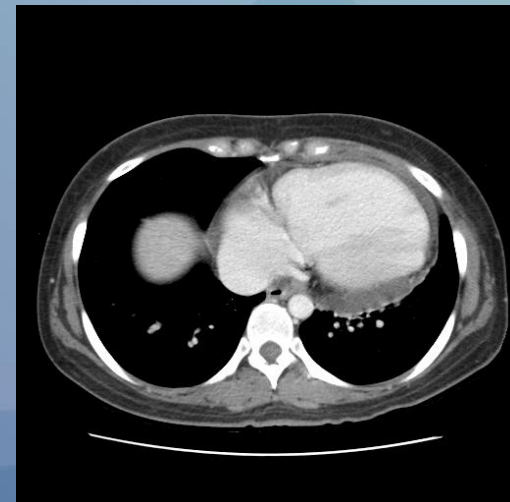
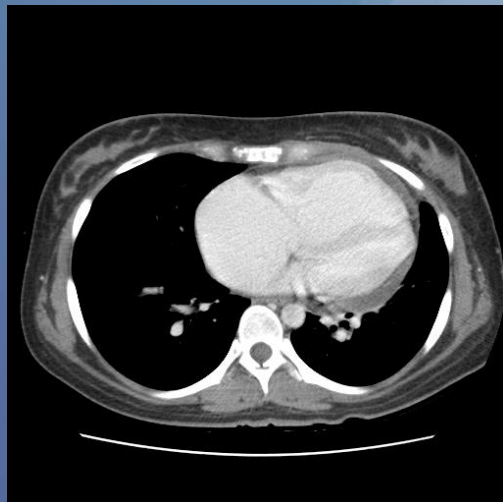
HBsAg/Ab (-/-) HCV-Ab(-)

**FANA speckled 1:1280 anti-ds-DNA 13.6 IU/mL anti-U1RNP (+)**  
**anti-SSA(Ro)/SSB(La) (+/equivocal) C3/C4/CH50 197mg/dL/15.1 mg/dL/47.2U/ml**  
**RF factor (-) ANCA (-)**  
**Lupus anticoagulant (-) ACA IgG/IgM (-/+) Beta2-GPI IgG/IgM (-/-)**

TSH/free T4 5.7uU/mL, 1.5 ng/dL



# Case 3 (F/31)



# Case 3 (F/31)

Echo : LV EF 68% E/E' 9 D-shape LV

**TR Vmax 4.2 m/s, PG(RV-RA) 71 mmHg**

**RV wall thickness 6mm**

-> severe resting PH with RV dysfunction

PFT: FEV1/FVC 82% **FEV1 55% pred. FVC 52% pred.**

**DLco 42 % pred.**

6MWD 200m (SaO<sub>2</sub> 93%)

RHC: **sPAP/dPAP/mPAP 90/51/57 mmHg PCWP 10 mmHg**

**CO 2.37 L/m (CI 2.4) PVR 19 WU**



# Case 3 (M/28)      Diagnosis and treatment

**SLE-PAH with ILD**

**Bosentan 62.5 mg bid and mPD 1mg/kd,**

	2014.01.07	2014.01.18	2014.03.05
TRVmax	4.2	3.3	
PGsys(RV-RA)	71	44	
BNP	535		26
6MWD	200		440
FVC	55% pred.		73% pred.
DLco	42% pred.		51% pred



# Case 4 (F/26)

2003 .04 노작성 호흡곤란(Fc III)로 본원 내원하여

Echo: **Large secundum ASD with Left-to right shunt**  
TR Vmas 4.0m/s

RHC: mRAP 3 mmHg **mPAP 43 mmHg**  
**Qp/Qs 1.5** Rp/Rs 0.32

2003. 05. 14 본원 흉부외과에서 **ASD direct closure** 시행함.

수술 이후 심초음파상 폐고혈압으로 **beraprost 0.04mg tid** 투여



# Case 4 (F/26)

2006. 11. 노작성 호흡곤란(Fc III)로 악화

RHC : mRAP 5 mmHg mPAP 32 mmHg PAWP 10 mmHg

2006. 11. 29 **Bosentan** 임상연구 등록되어 투여

2007. 03. 환자 외래 내원 중단



# Case 4 (F/26)

2009. 03 호흡곤란 악화로 재내원하여 bosentan 재투여 시작
2009. 05 호흡곤란 호전되어 bosentan 임의로 투여 중단
2010. 03 bosentan 재투여 시작
2010. 07 환자 자의로 bosentan 임의로 투여 중단
2011. 02. 14 호흡곤란 악화 하지 부종으로 bosentan 재투여 시작함.
2012. 04. 25 호흡곤란 악화, 청색증 동반되어  
bosentan+sildenafil 병합 투여 시작함.



# Case 4 (F/26)

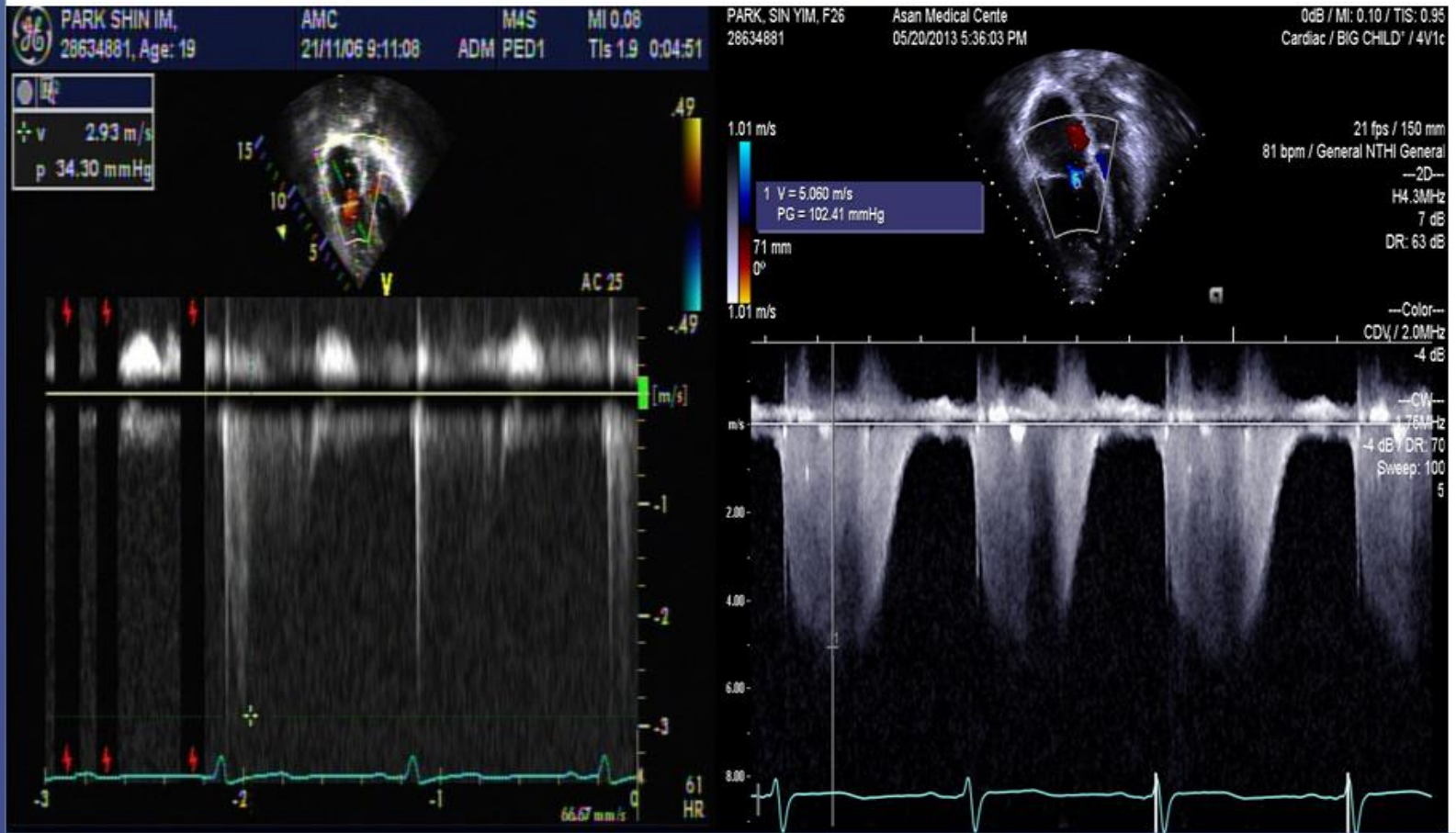
- 2013. 06. 25 ASD creation (Atrial septectomy) 시행함.
- 2013. 07. 07 Pneumonia with Septic shock으로  
VA ECMO 시행
- 2013. 07. 21 Heart-lung transplantation 시행함.



# Case 4 (F/26)

2006년 11월 Bosentan 투여 직전

2013년 05월 ASD creation 직전



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Asan Medical Center



PHT Center  
Pulmonary Hypertension & Venous Thrombosis Center  
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# Case 4 (F/26)

ASD Repair 수술 당시  
심폐이식 수술 10년 전



심폐이식 수술 1일전



Bosentan 투여 시작 당시  
심폐이식 수술 7년 전



심폐이식 수술 1일 후



ASD creation 당시  
심폐이식 수술 1달 전

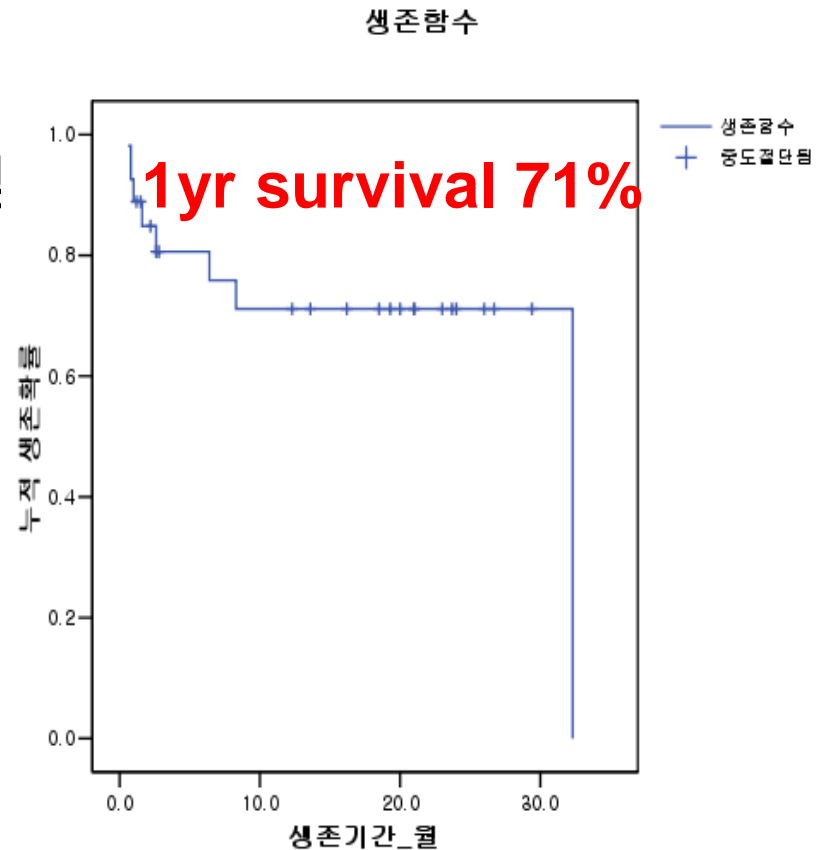


심폐이식 수술 3개월



# Lung transplantation in AMC

- 2008.10 ~ 2013.9
- → 29명에서 폐이식 시행
- ILD : 10명
- ARDS : 9명
- BO after BMT : 4명
- 기타 : 4명



# Case 5 (M/28)

- C. C : **Hemoptysis** ( 100-150cc, 5 days ago)
- P. I: 2YA intermittent hemoptysis
  - > 5 days ago hemoptysis -> BFS, chest CT (LLL bleeding)
  - bronchial artery embolization
  - Echocardiography: EF 21%, biventricular dysfunction**
- P.M. Hx: epilepsy -> carbamazepine
- R. O. S: cough (+), sputum (-) dyspnea (-) chest pain (-)
- P/Ex.: BP 154/104 mmHg PR 104/min
  - jugular vein distension (+)
  - RHB without murmur
  - Pretibial pitting edema (-)

# Case 5 (M/28)

Lab.: CBC 11600-16.0-221K

PT (INR) 0.97 aPTT 27.4s

BUN/Cr 14/0.98 mg/dL Protein/albumin 6.2/3.8 g/dL

AST/ALT 16/14 IU/L T.B 0.8 mg/dL

CRP 1.14 mg/dL

**BNP 209 pg/mL**

U/A albumin (-) RBC (-) WBC (-)

ABGA 7.43-34-82-23.0-96%

HBsAg/Ab (-/-) HCV-Ab(-)

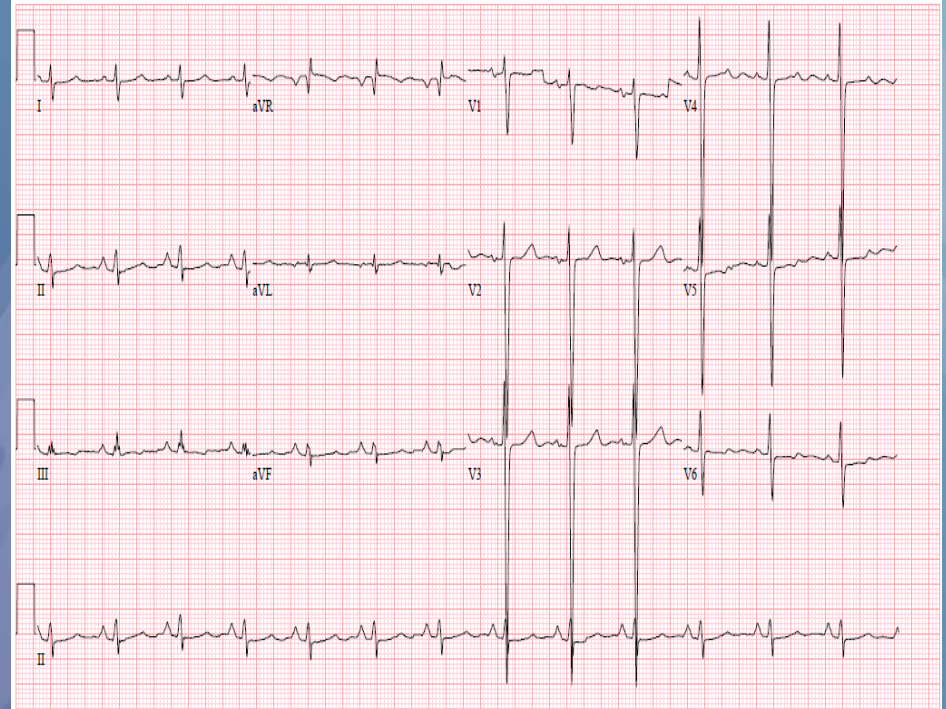
**FANA (-) RF factor (-) ANCA (-)**

**Lupus anticoagulant (-) ACA IgG/IgM (-/-) Beta2-GPI IgG/IgM (-/-)**

TSH/free T4 9.8uU/mL, 1.5 ng/dL



# Case 5 (M/28) : CXR, EKG, Echo.



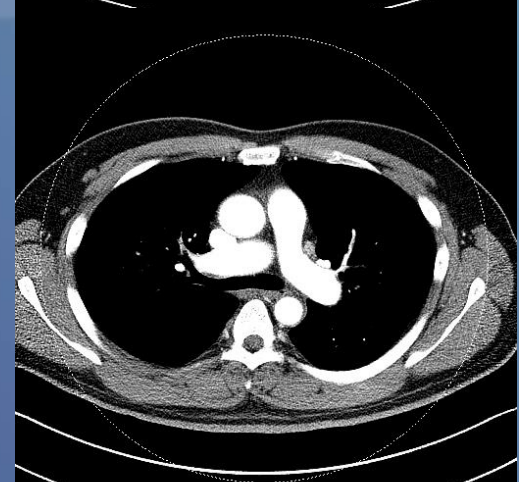
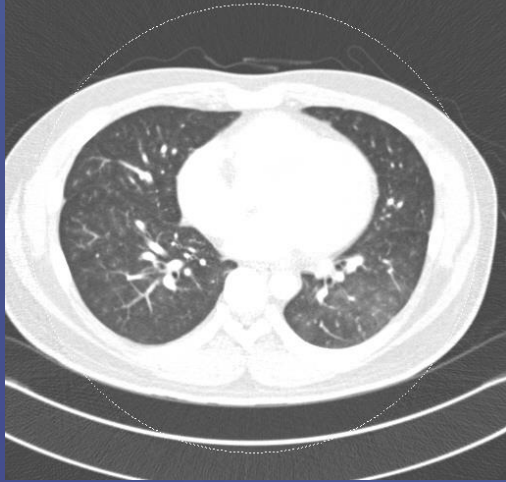
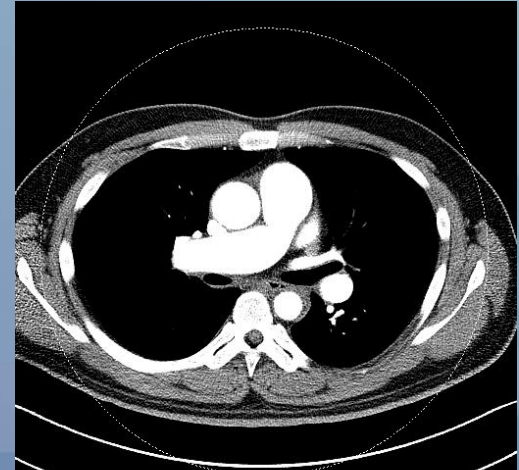
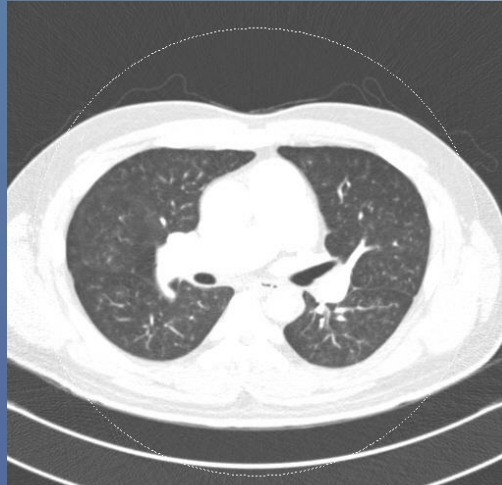
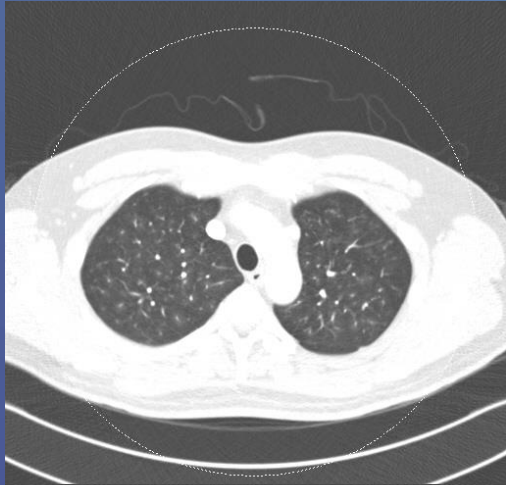
Echo : **LVEF 26%, E/E' 18, D-shape LV**

**TR Vmax 측정 불가**

**Enlarged LV with thickened LV wall and severe LV dysfunction**

**RV dysfunction with resting PH and increased LV filling pressure**

# Case 5 (M/28) Chest CT



# Case 5 (M/28) bronchial arteriography



# Case 5 (M/28)

# V/Q scan

Patient Name: AHN JAEDEOK, M28  
Study Date: 10/2/2012

Patient ID: 44482006

Study Name: Lung Ventilation Scan

Lung Inhalation Scan  
Pertechnegas



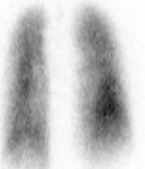
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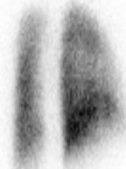
LAO



LPO



POST



RPO



RAO

Patient Name: AHN JAEDEOK, M28  
Study Date: 10/2/2012

Patient ID: 44482006

Study Name: Lung Perfusion Scan

Lung Perfusion Scan  
99mTc-MAA



ANT



LAO



LPO



POST



RPO



RAO



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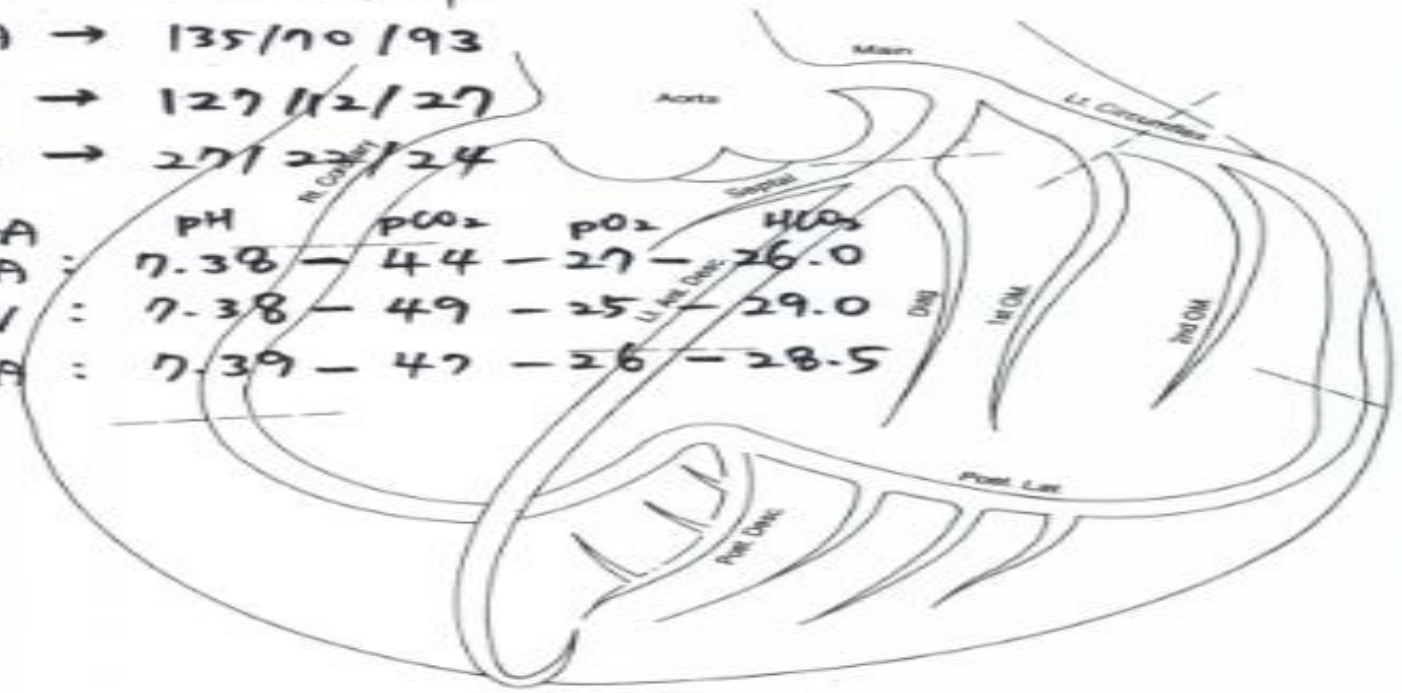
# Case 5 (M/28) RHC

\* Rt Cath 시행함

PCW → Mean: 28  
 RPA → 105/59/76  
 LPA → 135/70/94  
 MPA → 135/70/93  
 RV → 127/12/27  
 RA → 27/22/24

\* ABGA

	pH	pCO <sub>2</sub>	pO <sub>2</sub>	HCO <sub>3</sub>
MPA	7.38	44	27	26.0
RV	7.38	49	25	29.0
RA	7.39	47	26	28.5



# Case 5 (M/28) Dx. and Tx.

## “Out-of PH” associated with DCMP

Losartan 50mg qd, spironolactone 12.5mg qd, bisoprolol 2.5mg qd  
Atorvastatin 10mg qd, ISDN 20mg bid

**Sildenafil 25mg tid**

	2012.09	2012.12	2013.04	2013.10
<b>EF</b>	<b>26%</b>			<b>45%</b>
<b>TRVmax</b>	-			<b>3.3</b>
<b>PGsys(RV-RA)</b>	<b>100mmHg</b>			<b>44mmHg</b>
<b>BNP</b>	<b>209</b>	<b>30</b>	<b>40</b>	
<b>6MWD</b>	<b>465m</b>	<b>492m</b>	<b>560m</b>	<b>555m</b>



# Case 6. (64/M)

**Chief complaint** : dyspnea (WHO II)

Present illness

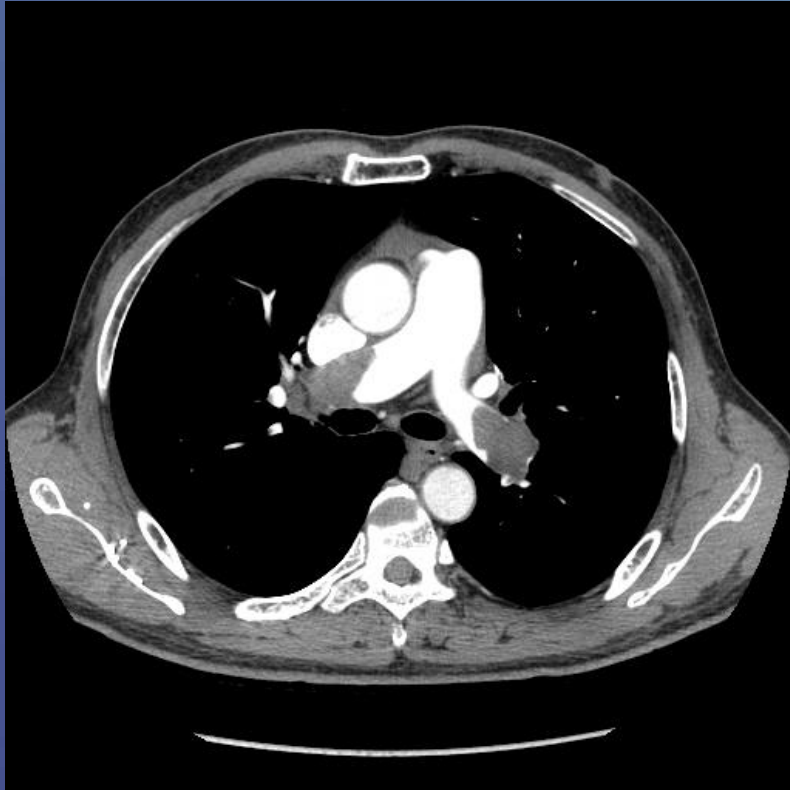
내원 9년 전 실신으로 외부병원 입원하여 **acute PE with DVT**로 **thrombolysis** 치료 시행 후 **warfarin** 복용함.

내원 2년 전 심장초음파상 우심기능이상 동반한 폐고혈압으로 **sildenafil** 복용

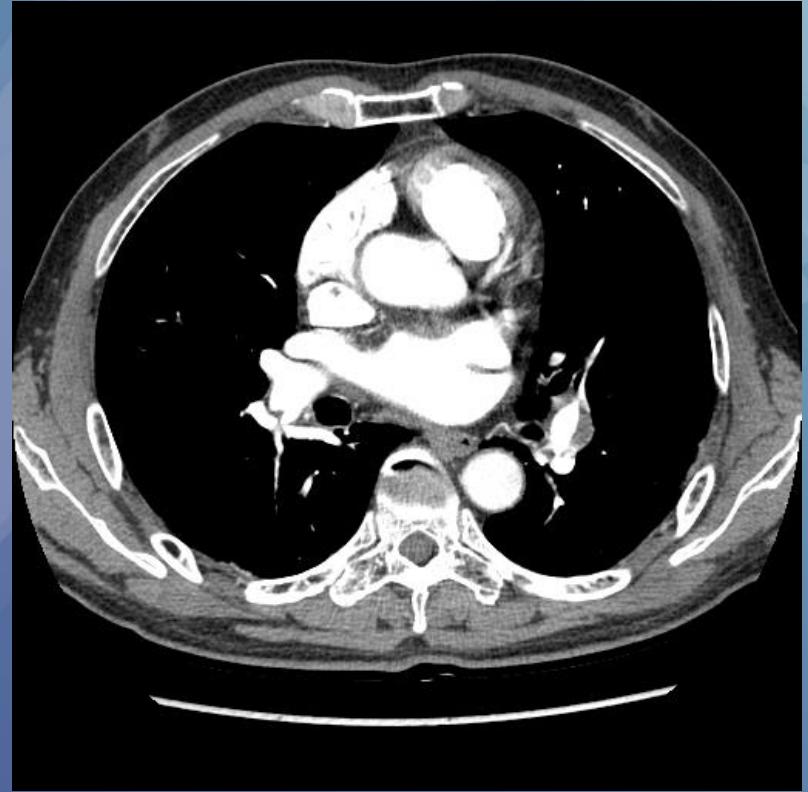
내원 3개월 전 검진 위내시경검사에서 조기위암으로 수술 위해 내원



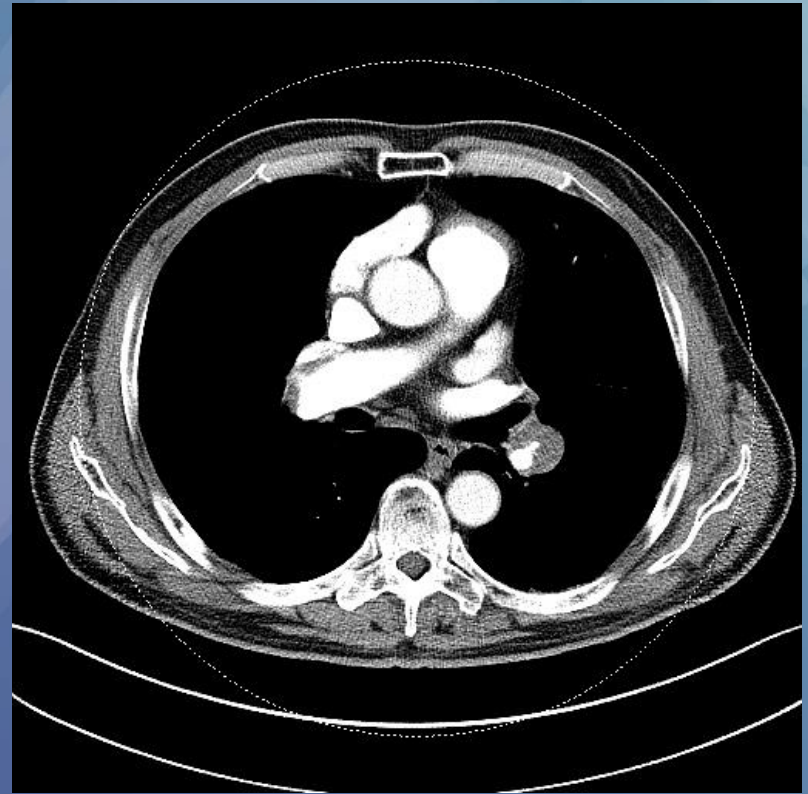
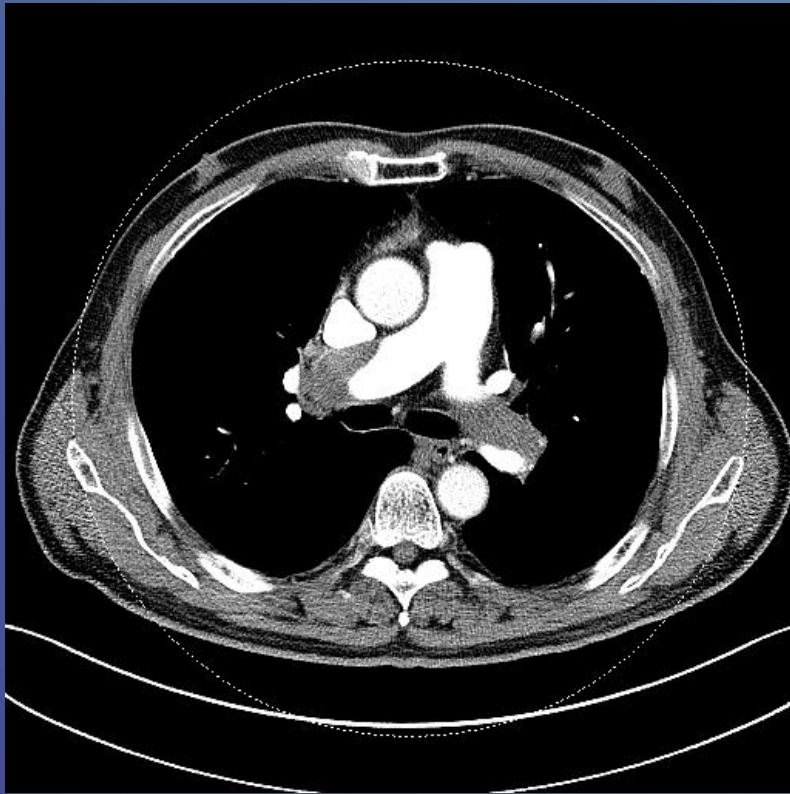
# Case 6; Chest CT (9 years ago)



# Case 6; Chest CT (after thrombolysis)



# Case 6; Chest CT(1 week ago)



# Case 6; Preoperative echo

## Left Ventricle D-shaped LV

LVIDs	<b>34</b> mm	LVIDd	<b>48</b> mm	LA	<b>40</b> mm	Aorta	<b>37</b> mm
LVPWs	<b>13</b> mm	LVPWd	<b>10</b> mm	ESV	<b>39</b> mL	EDV	<b>115</b> mL
IVSs	<b>13</b> mm	IVSd	<b>9</b> mm	LVEF	<b>66</b> %	LV Mass	<b>159.7</b> g
P.E. (ant)	mm	P.E. (post)	mm	LV Mass Index	<b>88.1</b> g/m <sup>2</sup>		

## Right Ventricle decreased contractility(Ts 4.4 cm/sec)

RVIDs	mm	RVIDd	mm
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## Tricuspid Valve mild tethering

TR grade	<b>2</b>	TR jet area	<b>6</b> cm <sup>2</sup>	Peak TR Vel	<b>4.4</b> m/s
PGsys(RV-RA)	<b>77</b> mmHg	Peak E Vel	cm/s	Peak A Vel	cm/s

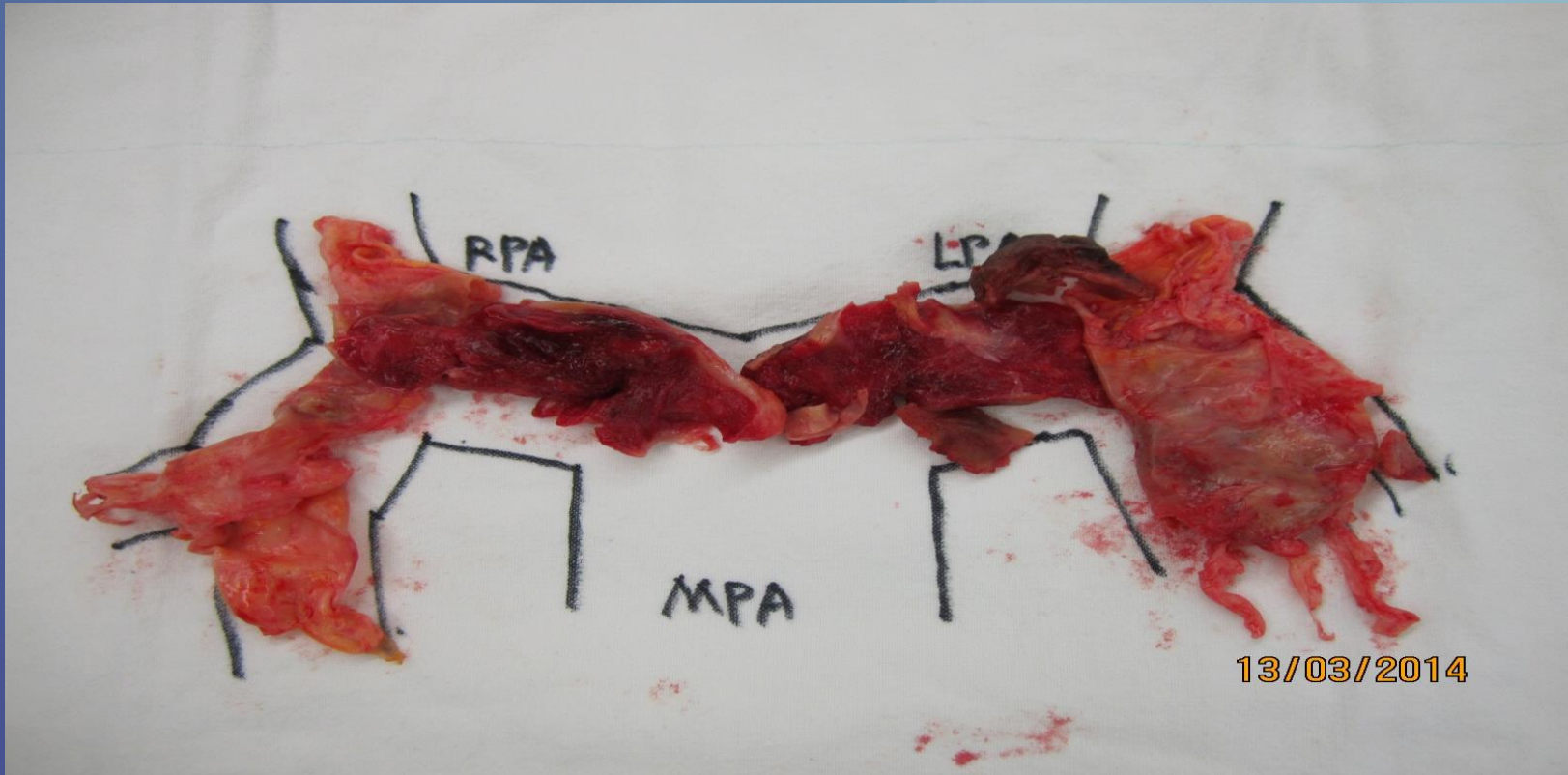
# Case 6; Preoperative RHC

		max	min	mean
Assumed VO <sub>2</sub> (ml/min/m <sup>2</sup> )			227.5	
Hemoglobin (g/dL)			16.9	
Aorta	Pressure	98	57	74
Aorta(PV)	Saturation		97	
Aorta(PV)	PaO <sub>2</sub>		85	
SVC	Saturation		62	
IVC	Saturation		63	
MV O <sub>2</sub>			62.25	
RA	Pressure	14	9	9
RV	Pressure	82	6	14
MPA	Pressure	88	22	42
	Saturation		59	
	PaO <sub>2</sub>		25	
PCW(LA)	Pressure	12	11	10

PBF(Q <sub>p</sub> ) (L/min)	2.55
SBF(Q <sub>s</sub> ) (L/min)	2.79
Q <sub>p</sub> /Q <sub>s</sub>	0.92
Total PVR (Wood units)	12.54



# Case 6: Pulmonary endarterectomy (PEA)



Tricuspid Valve mild tethering

TR grade	1	TR jet area	cm <sup>2</sup>	Peak TR Vel	3.5 m/s
PGsys(RV-RA)	49 mmHg	Peak E Vel	cm/s	Peak A Vel	cm/s

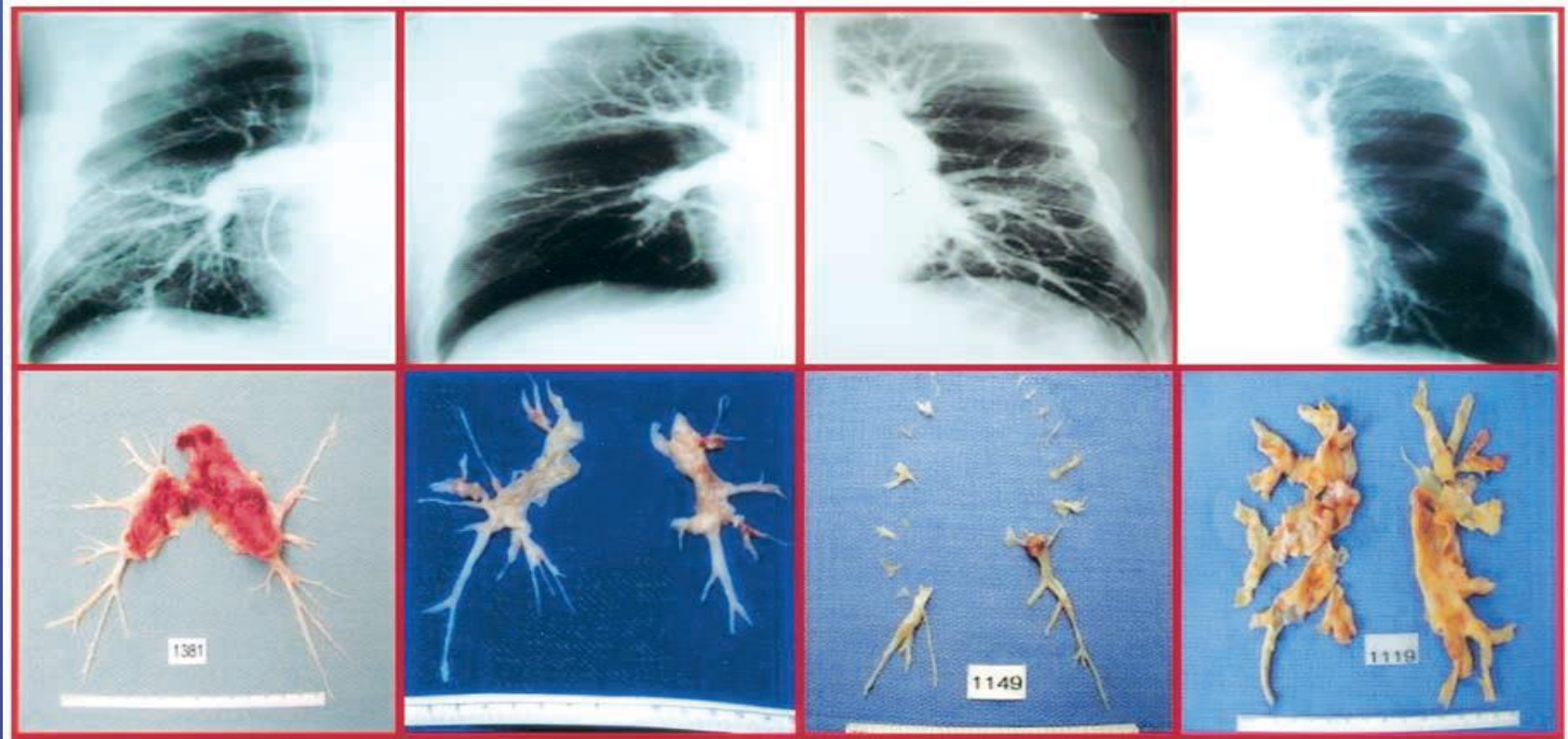
# Operative classification of CTEPH

Fresh thrombus  
in main-lobar  
arteries

Organized thrombus  
and intimal thickening  
proximal to segmental  
arteries

Intimal thickening-  
fibrosis in distal  
segmental arteries

Distal arteriolar  
vasculopathy



Type 1

Type 2

Type 3

Type 4



# PEA in AMC

	Type I, II (n=16)	Type III (n=10)	P-value
Ventilator care(hr)	48±74	137±195	0.13
ICU stay (days)	5±3	9±7	0.07
Reperfusion edema (n)	3 (18.8%)	4 (40%)	0.25
<b>In-hospital mortality</b>	<b>1 (6.3%)</b>	<b>2 (20%)</b>	
<b>5 year survival rate</b>	<b>92%</b>	<b>44%</b>	

Unpublished data



# Pulmonary artery intervention in AMC

Case 7. 51/M Stonecutter

C. C> : DOE (WHO Fc II)

PFT: FEV1/FVC 64% FEV1 78% pred. FVC 96% pred.  
DLco 91 % pred.

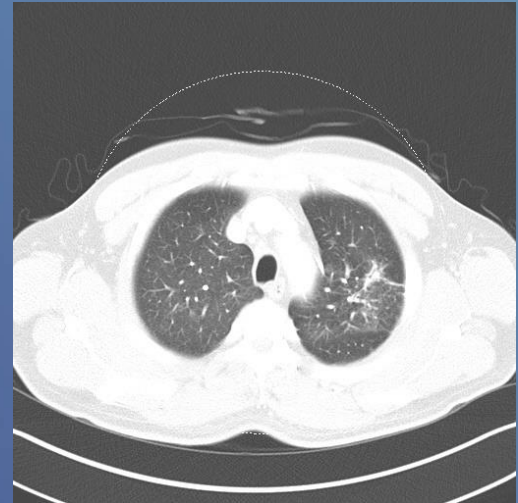
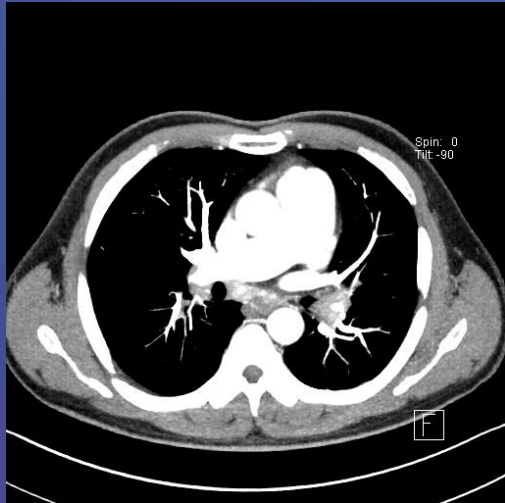
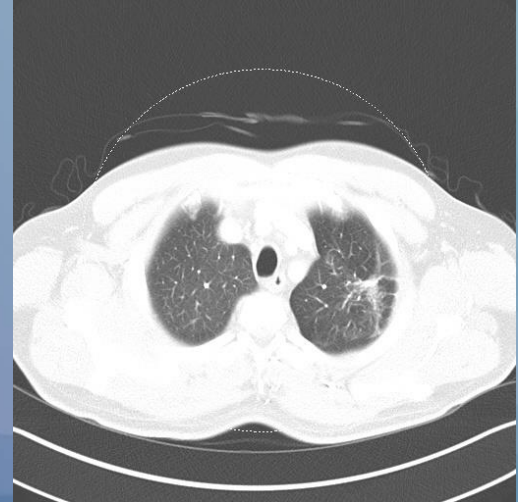
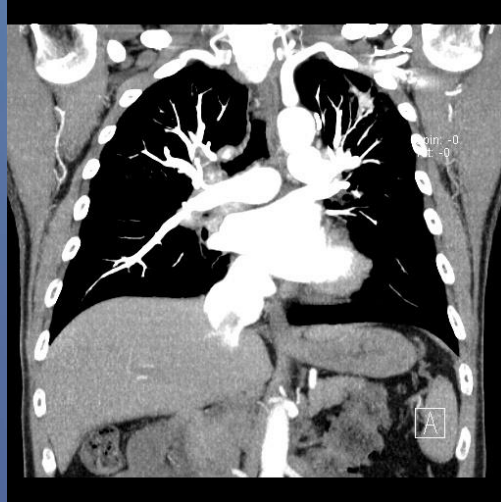
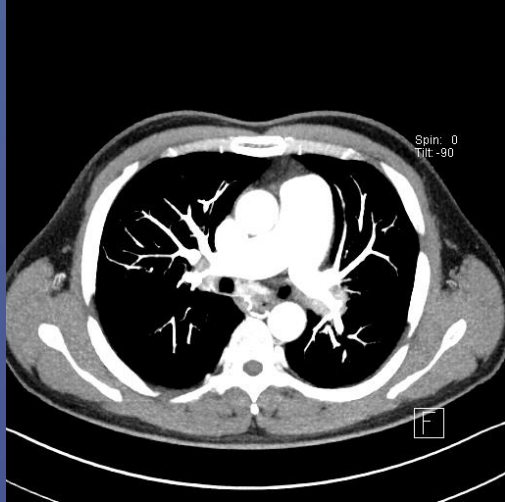
6MWD 490m (SaO2 94%)

Echo : **TR Vmax 3.9 m/s, PG(RV-RA) 61 mmHg**  
-> severe resting PH with RV dysfunction

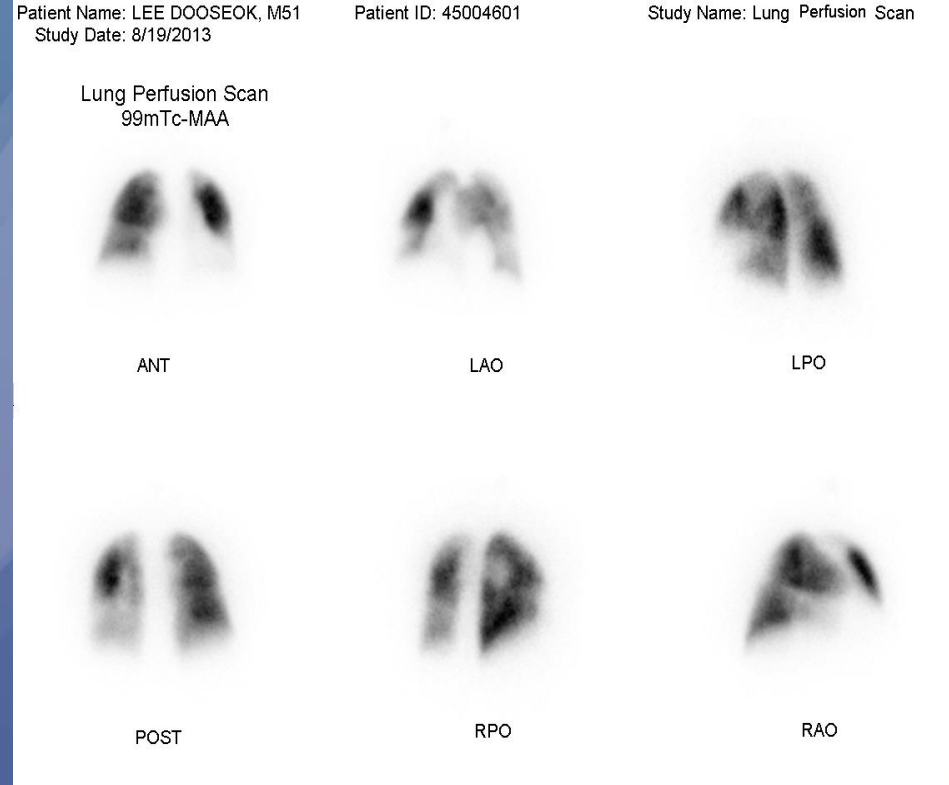
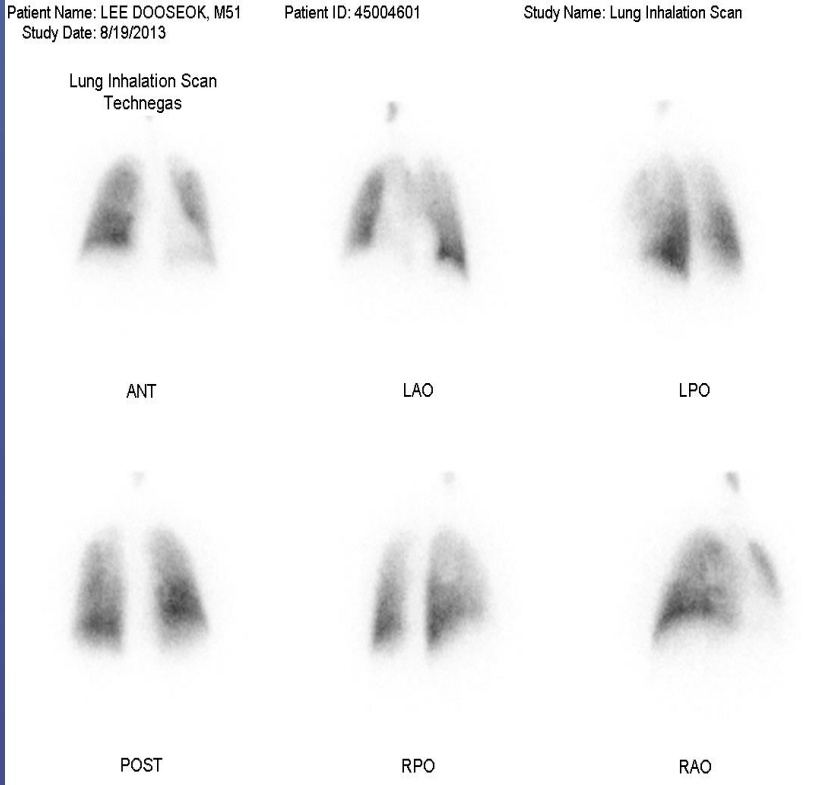
RHC: **sPAP/dPAP/mPAP 54/20/32 mmHg PCWP 68 mmHg CO 4.23 L/m**  
**PVR 4.78 WU**



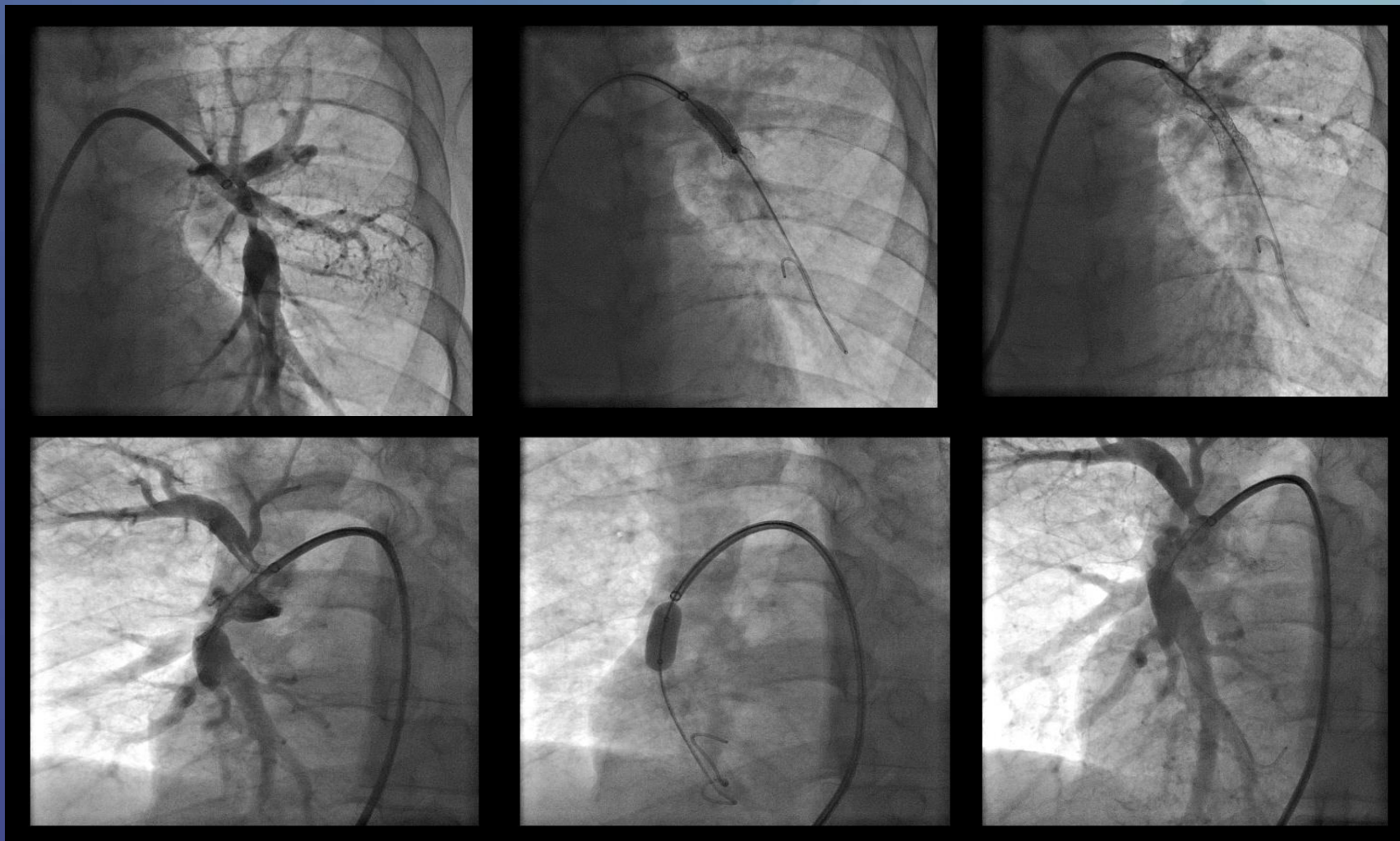
# Case 7; Chest CT

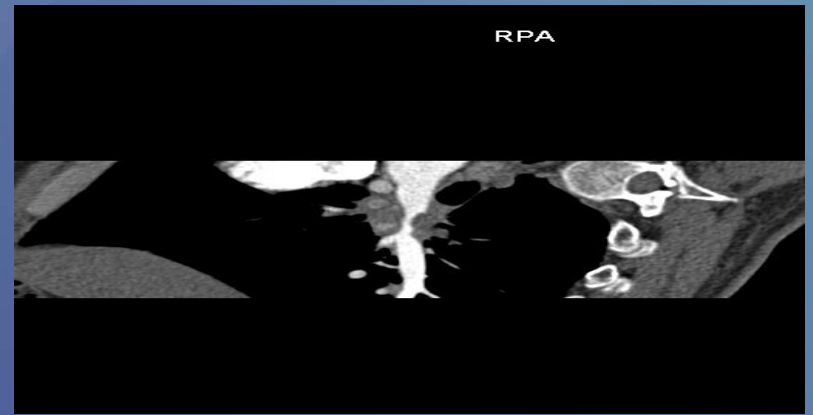
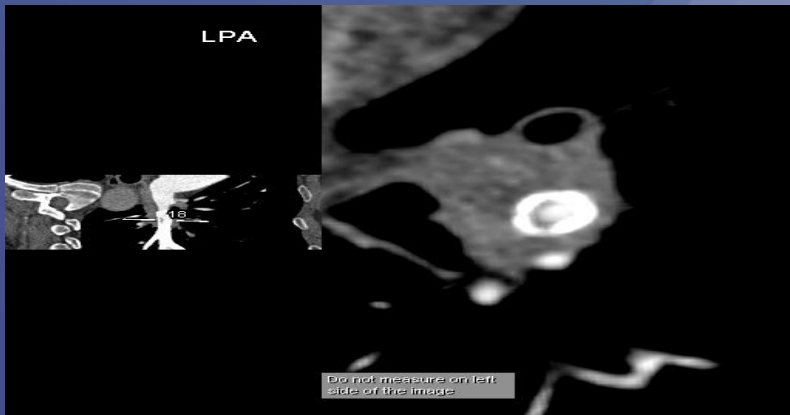
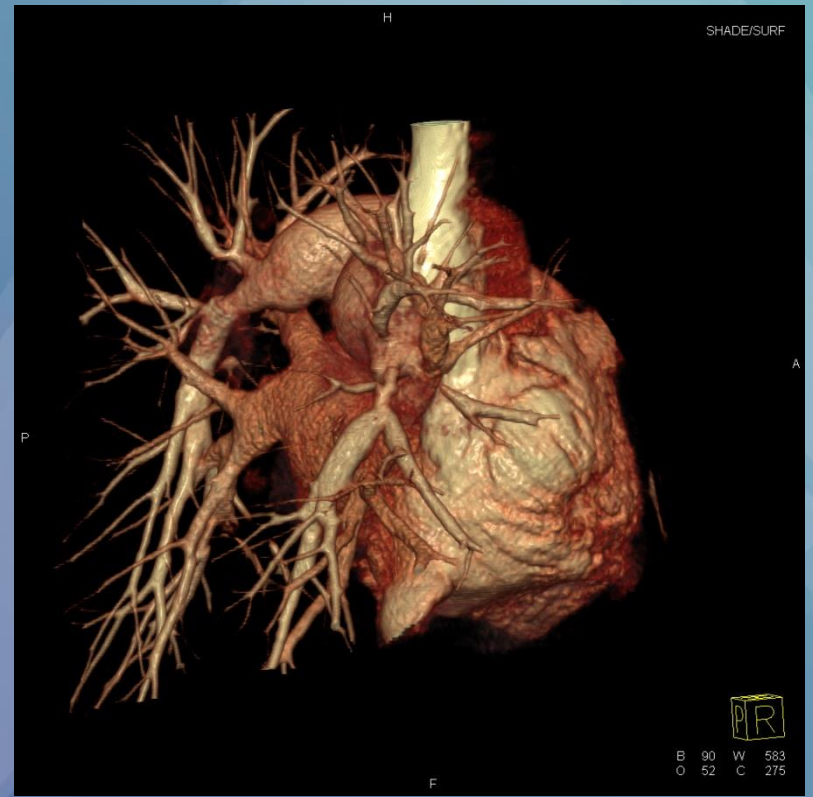
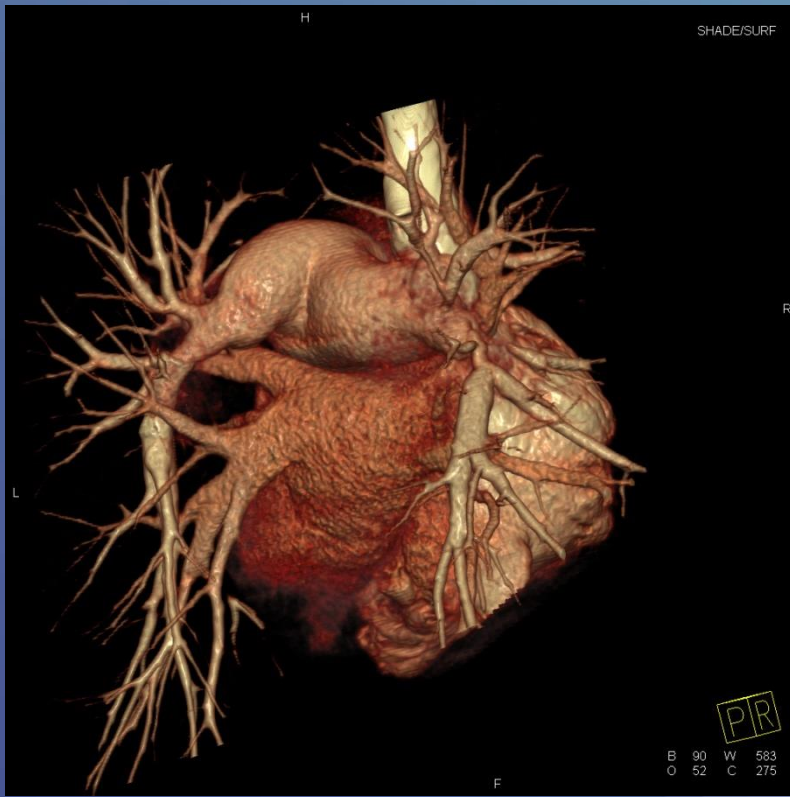


# Case 7; V/Q scan



# Case 7. Pulmonary artery balloon dilatation and stent insertion





**서울아산병원**  
Asan Medical Center



**Center**  
Pulmonary Hypertension & Venous Thrombosis Center  
폐고혈압·정맥혈전센터



# Case 8. 44/M

**C. C> : DOE (WHO Fc III) onset: 3 months ago**

**P. I. : 4YA paroxysmal AF -> amiodarone for 1 years**

**9MA RFCA**

**3MA DOE (FC II)**

**2WD DOE (FC III)**

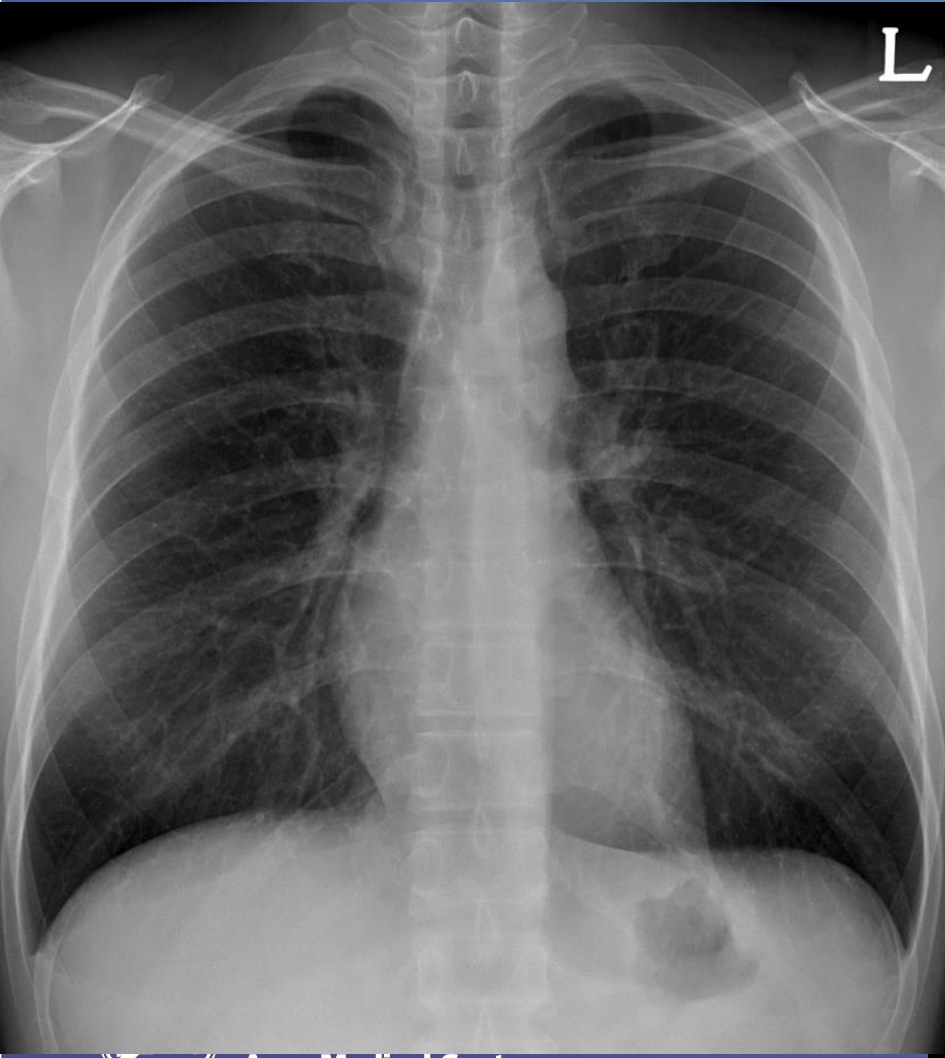
**Outside chest CT: suspicious ILD  
fibrosing mediastinitis**



# Case 8. 44/M

2013/03/06

2013/12/14 (Admission)



# Case 8; Echo

## Left Ventricle D-shaped LV

LVIDs	<b>27</b> mm	LVIDd	<b>42</b> mm	LA	<b>24</b> mm	Aorta	<b>28</b> mm
LVPWs	<b>15</b> mm	LVPWd	<b>10</b> mm	ESV	<b>15</b> mL	EDV	<b>43</b> mL
IVSs	<b>14</b> mm	IVSd	<b>10</b> mm	LVEF	<b>65</b> %	LV Mass	<b>138.0</b> g
P.E. (ant)	mm	P.E. (post)	mm	LV Mass Index	<b>77.2</b> g/m <sup>2</sup>		

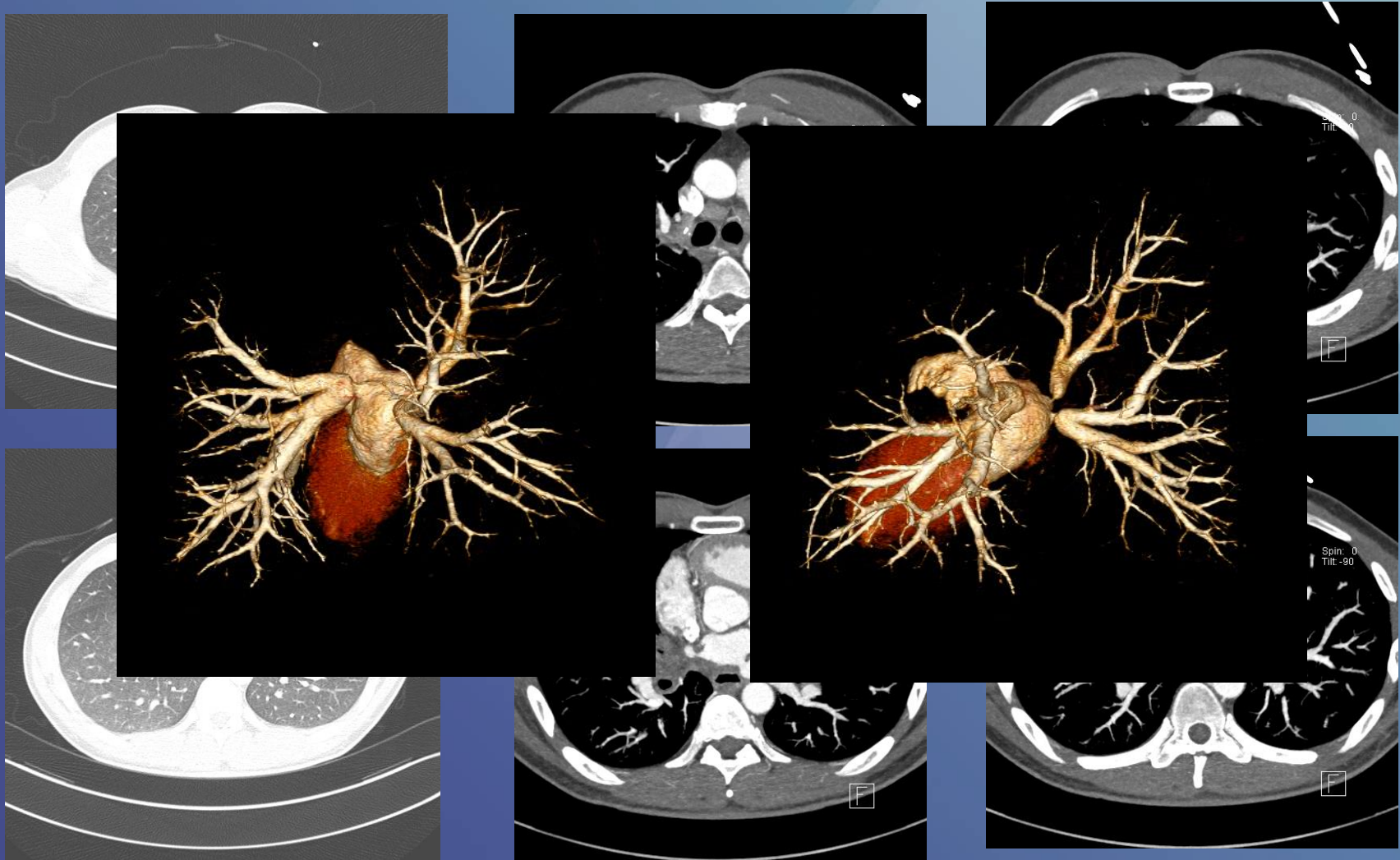
## Right Ventricle decreased contractility

RVIDs	mm	RVIDd	mm
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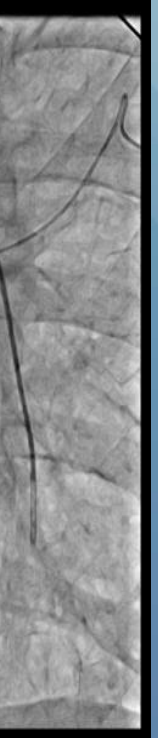
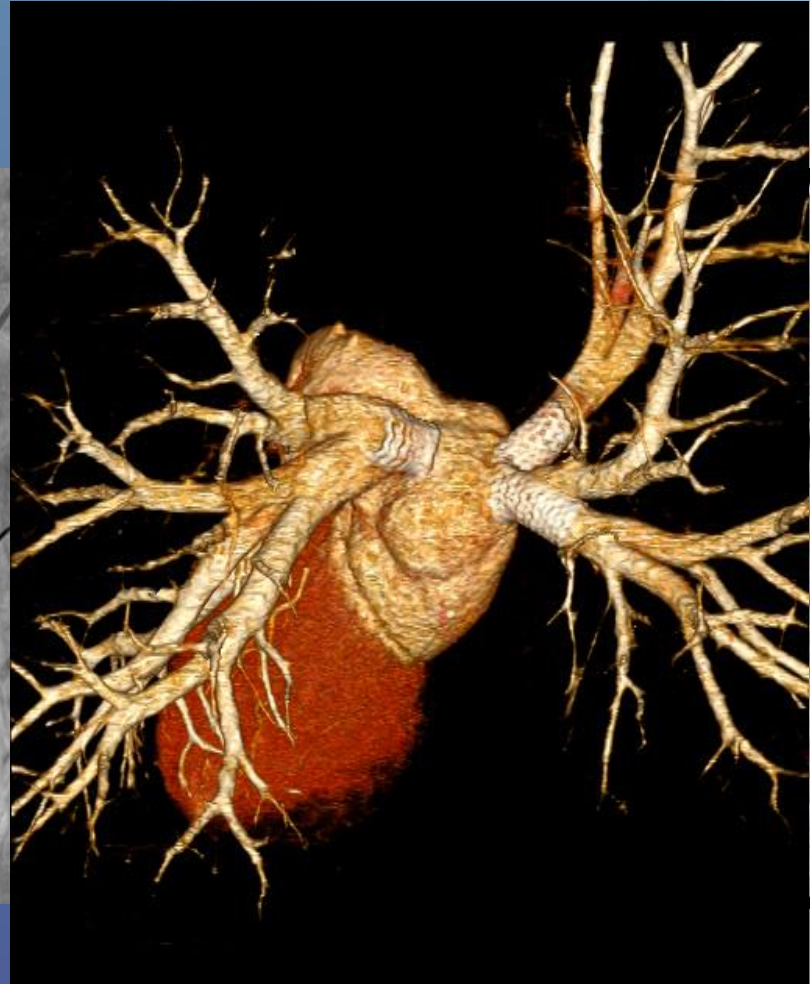
## Tricuspid Valve tethering

TR grade	<b>2-3</b>	TR jet area	cm <sup>2</sup>	Peak TR Vel	<b>4.5</b> m/s
PGsys(RV-RA)	<b>81</b> mmHg	Peak E Vel	cm/s	Peak A Vel	cm/s

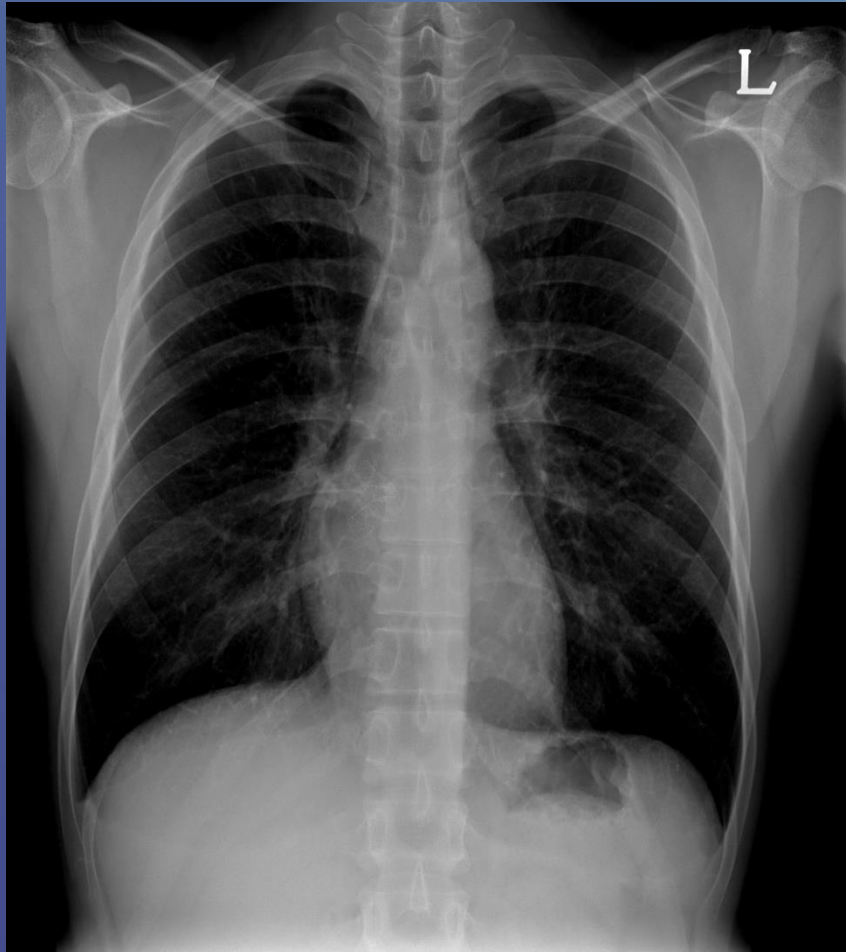
# Case 8; Pulmonary vein CT



# Case 8; Pulmonary vein balloon dilatation and stent insertion



# Case 8; 3 month CXR and Echo



## Left Ventricle Normal LV

LVIDs	33 mm	LVIDd	49 mm	LA	33 mm	Aorta	30 mm
LVPIs	13 mm	LVPI d	10 mm	ESV	53 ml	EDV	124 ml
IVSs	13 mm	IVSd	10 mm	LVEF	57 %	LV Mass	177.1 g
P.E.(ant)	mm	P.E.(post)	mm	LV Mass Index	95.7 g/m <sup>2</sup>		

## Right Ventricle preserved RV contractility (Tricuspid annulus DTI S velocity=13 c

RVIDs	mm	RVIDd	mm
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## Tricuspid Valve Normal

TR grade	1	TR jet area	cm <sup>2</sup>	Peak TR Vel	3.1 m/s
PGsys(RV-RA)	38 mmHg	Peak E Vel	cm/s	Peak A Vel	cm/s



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폐고혈압클리닉

통합진료

정맥혈전클리닉

1. **Comprehensive differential diagnosis**
2. **RHC with vasoreactivity test**
3. **Pulmonary endarterectomy (PEA)**
4. **Pulmonary balloon angioplasty**
5. **Congenital heart disease repair operation**
6. **Balloon atrial septostomy (BAS)**
7. **lung transplantation**

1. **Anticoagulation clinic**
2. **IVC filter**
3. **Catheter thrombolysis**
4. **Surgical embolectomy**