Case Presentation:

Problematic cases of Heart Transplantation

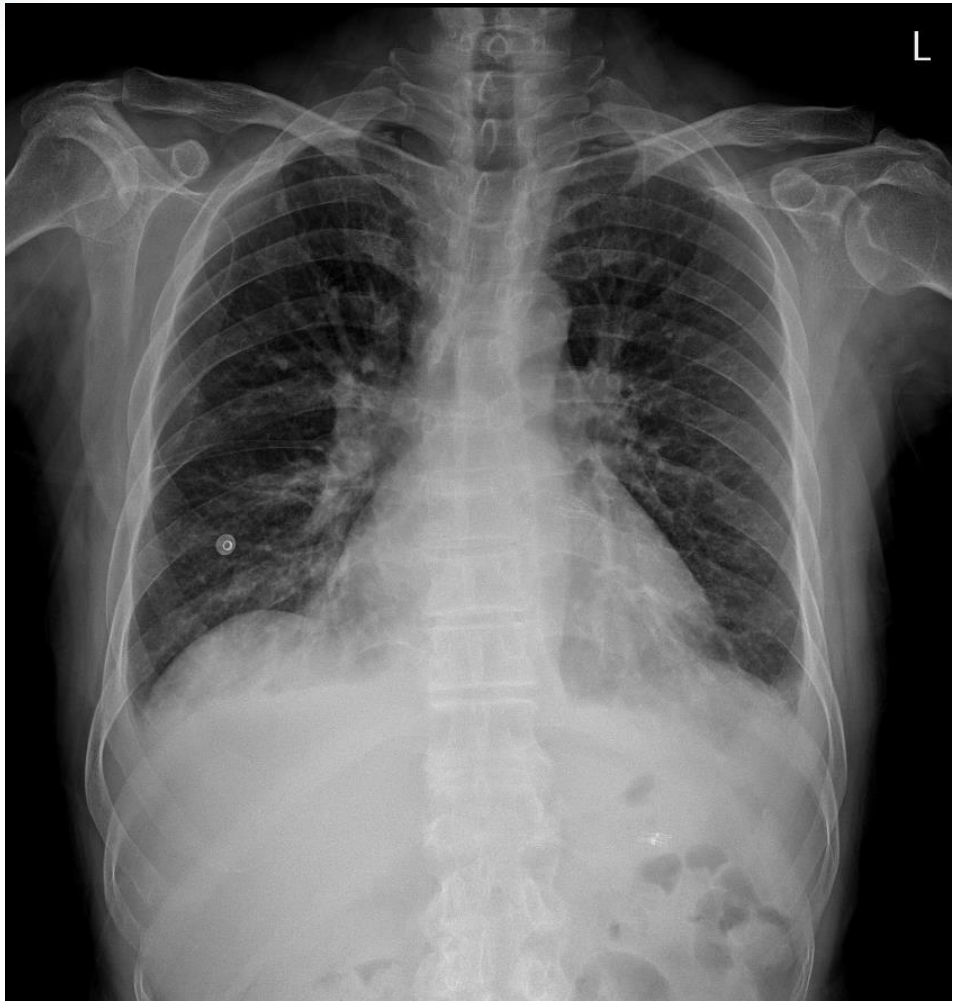
Thoracic and Cardiovascular Surgery Department
Keimyung University Dongsan Hospital
Woosung Jang, M.D., Ph.D.

SINCE 1899
계명대학교 동산병원
KEIMYUNG UNIVERSITY DONGSAN HOSPITAL

Disclosure

- **I have no relevant conflicts of interest to disclose regarding this presentation**

58 years old / Male (Rh+ A)



HFrEF (EF 30%)

Ischemic CMP

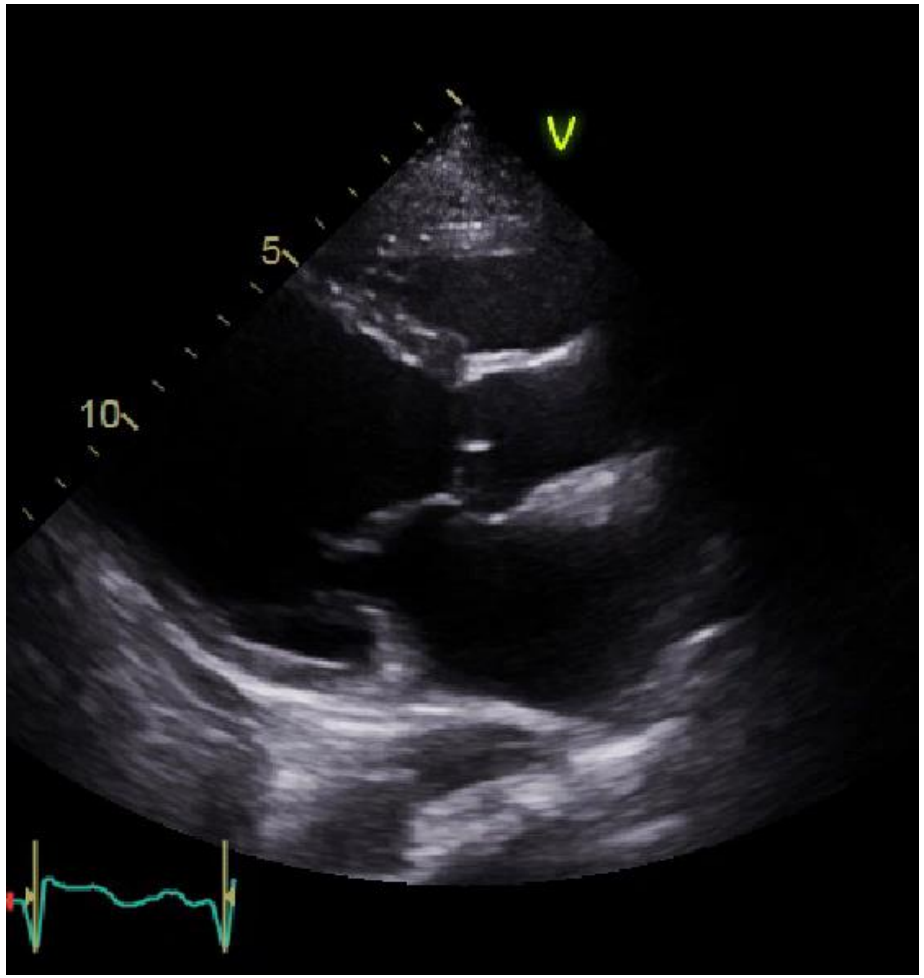
STEMI s/p P-PCI on LCXp (2018.10)

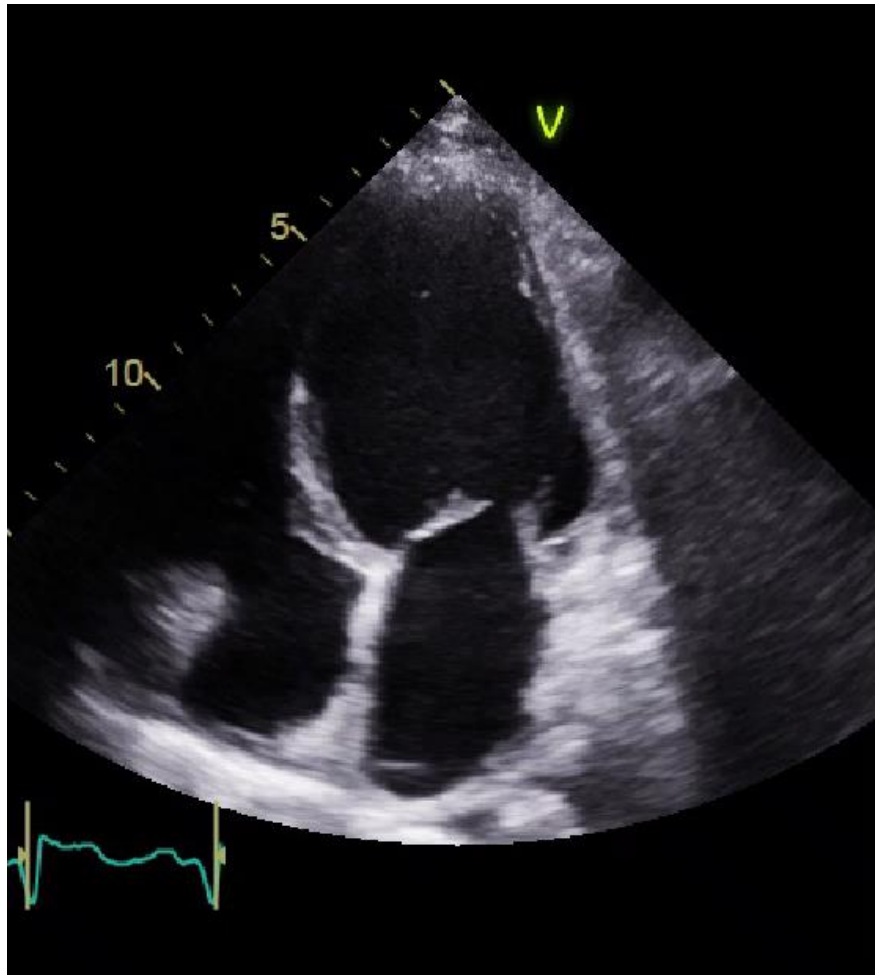
NSTEMI s/p PCI on LADm, LCXm (2008)

NSVT (2018.11.24)

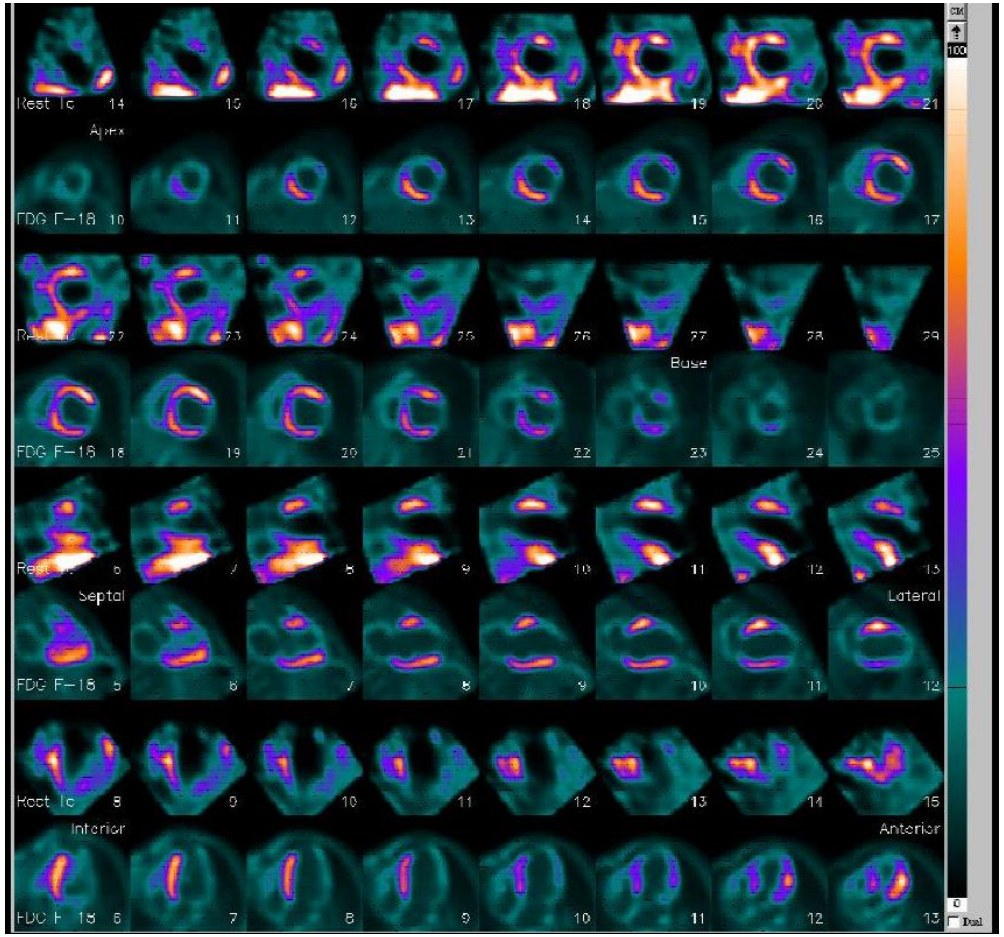
LAA thrombus (2018.11.24)

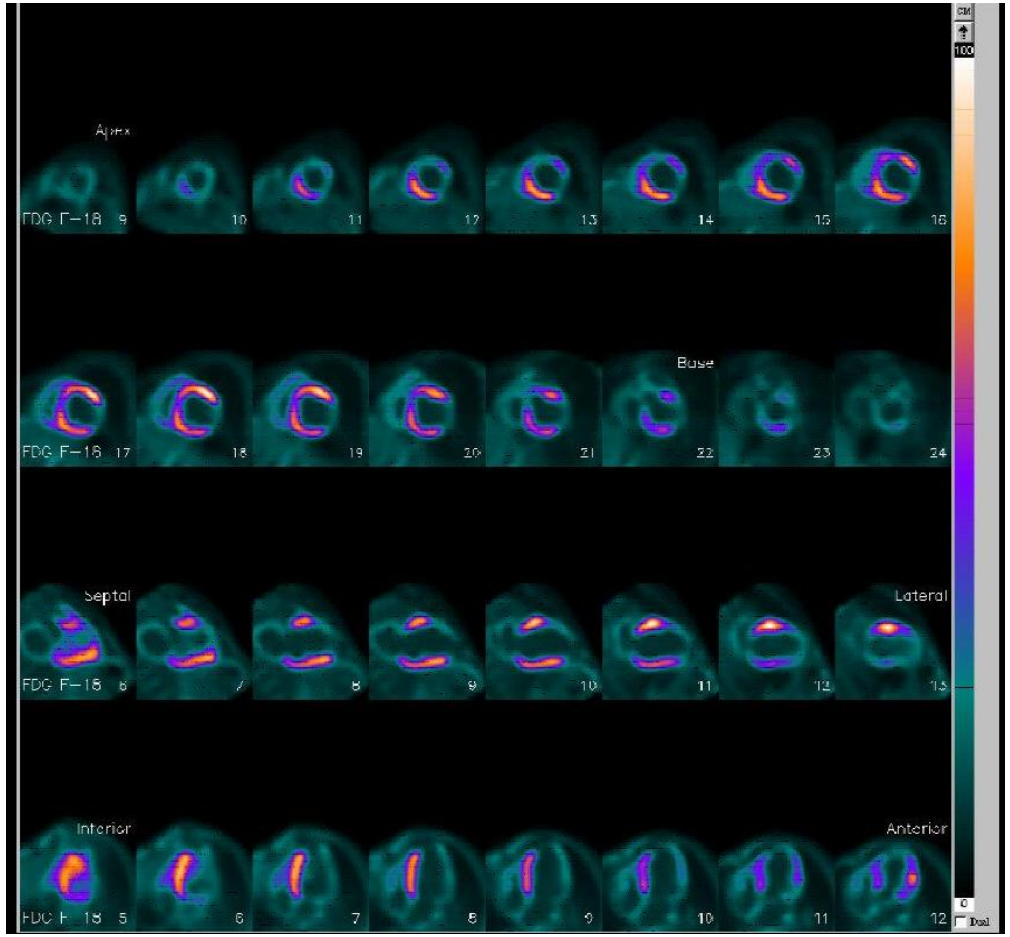
Echocardiography





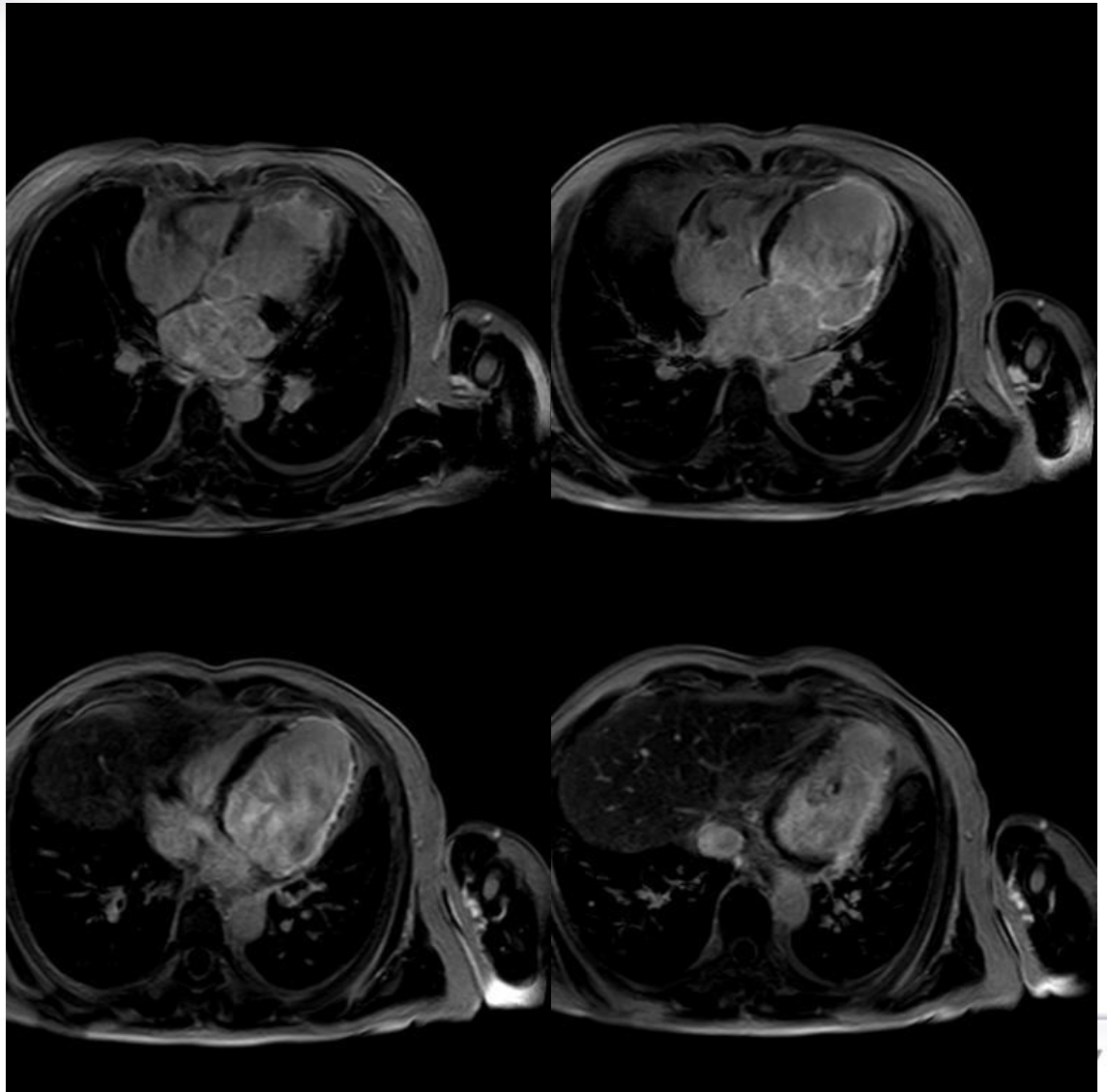
FDG-PET





Non-viable myocardium at LAD and LCX territory

Cardiac MRI

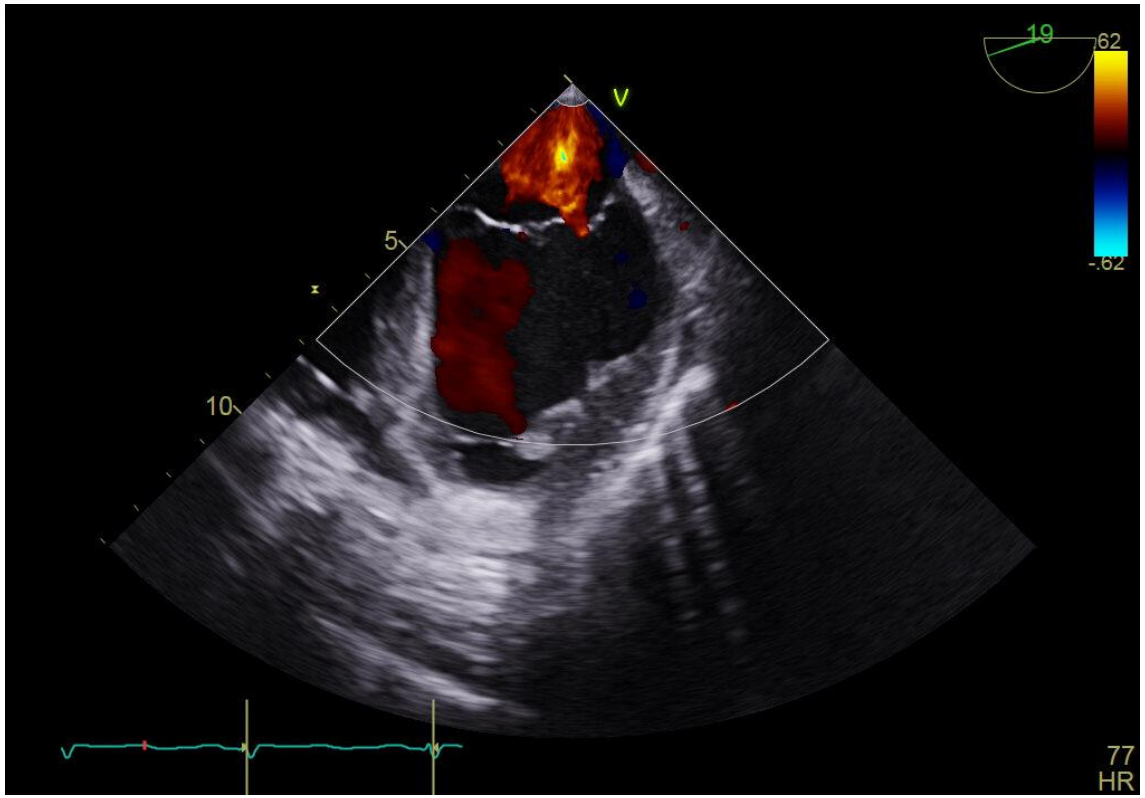


- Ischemic CMP with **extensive myocardial scar change (LAD & LCX territory)**

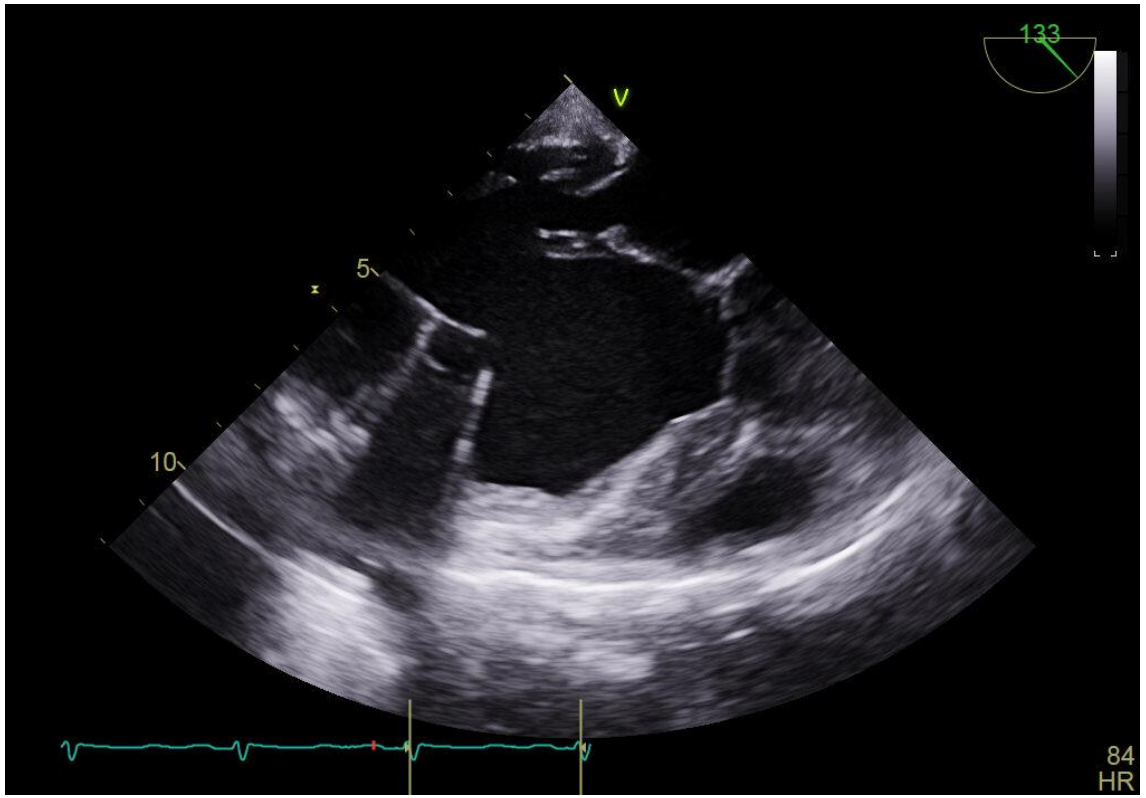
Problem List

- Ischemic CMP (HFrEF)
- Extensive fibrosis at LV myocardium
- Dobutamine dependent
- NYHA IV (III on dobutamine)
- Recurrent pulmonary edema & peripheral edema

BTT-LVAD (HVAD)

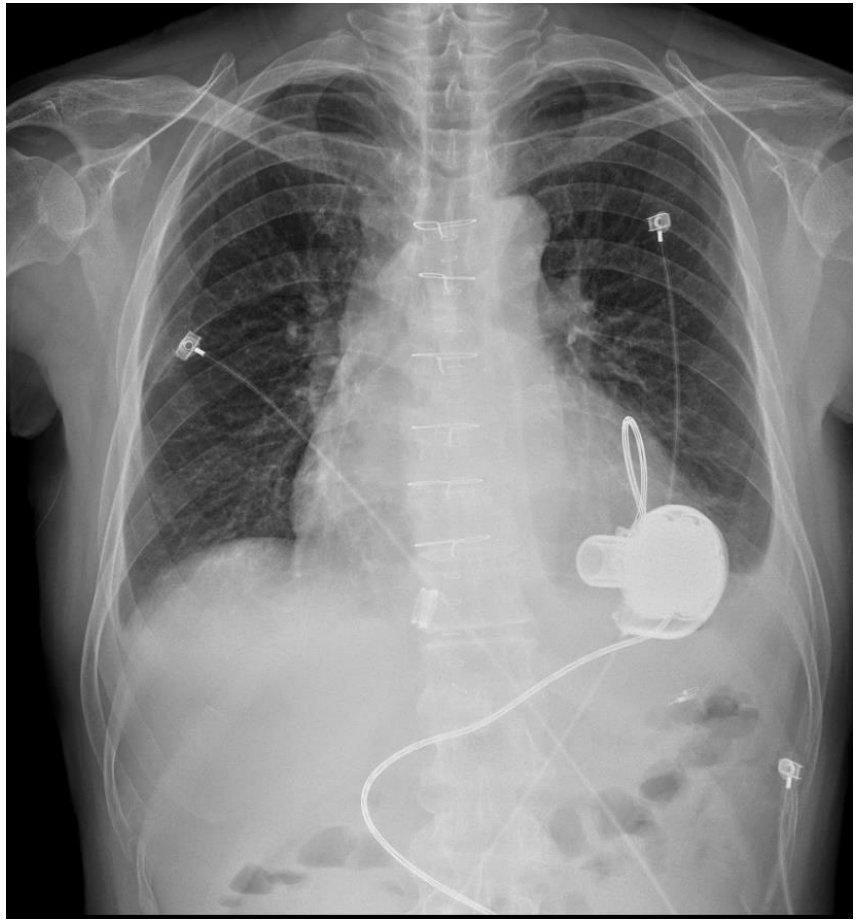


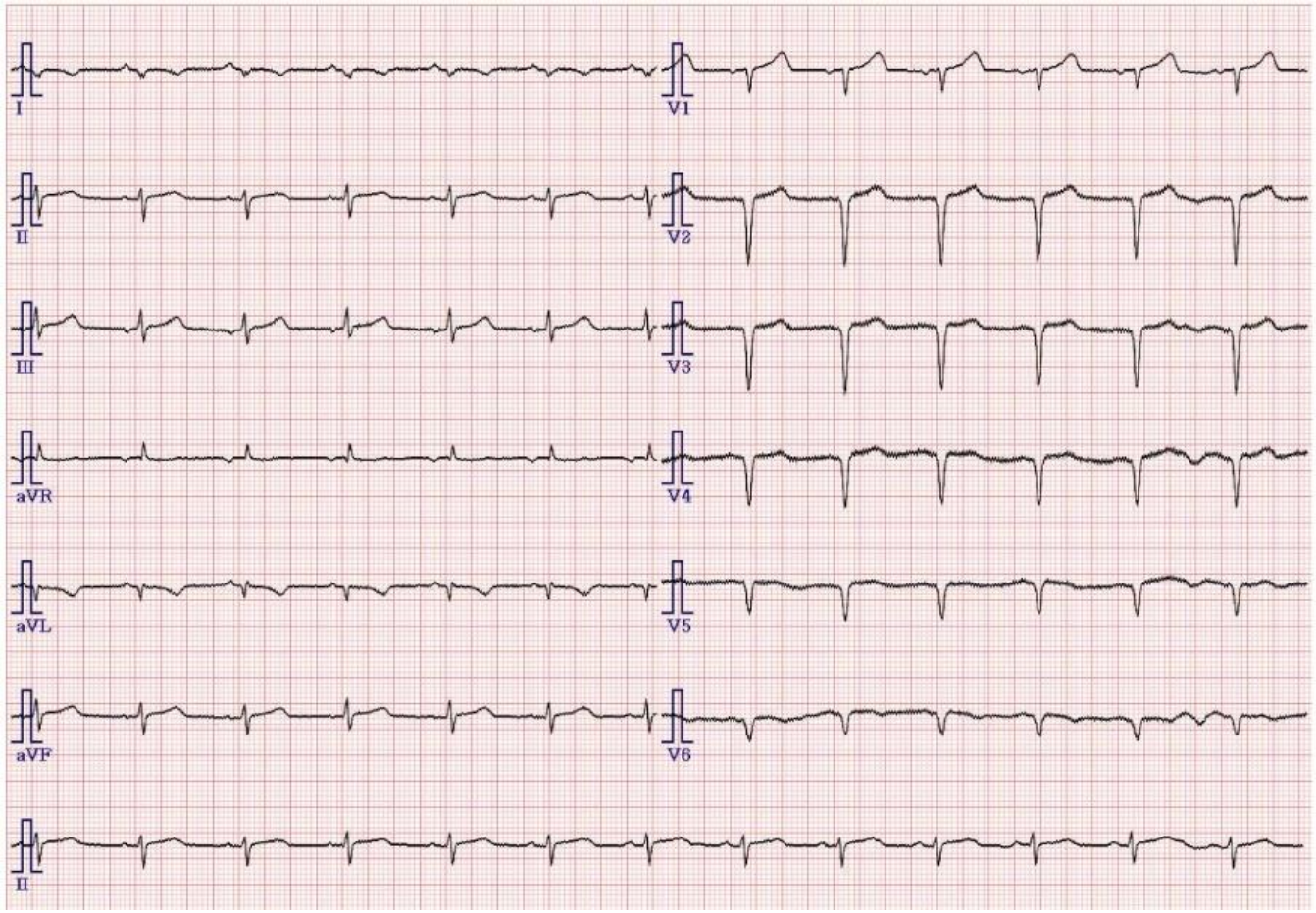
Pre-OP



Post-OP

Post-OP CXR & ECG





Hospital Course

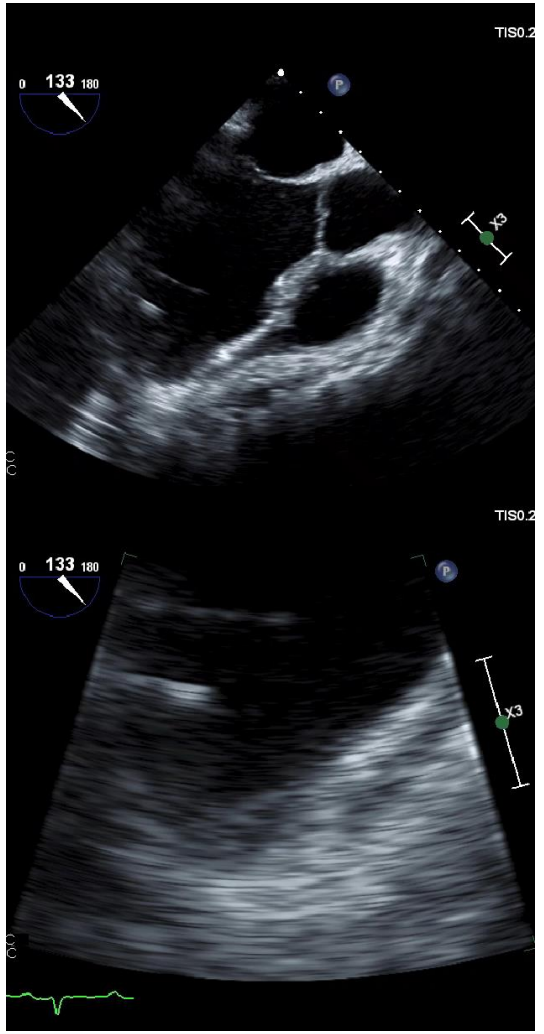
- **POD1: Ventilator weaning**
  - VAD RPM 2400, Flow 3.3L, 3.0 Watts
- **POD 7: Transfer to GW**
  - VAD RPM 2400, Flow 3.4L, 3.0 Watts
- **POD 36 Discharge after Rehabilitation**
  - VAD RPM 2400, Flow 3.5, 3.3 Watts
  - Warfarin 2.5mg + aspirin 100mg

Hospital Course

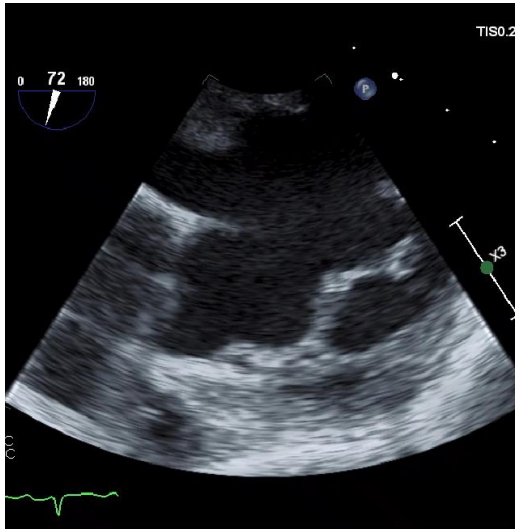
- **Several VAD related issues**

  - VAD infection (3 mo.)

  - Frequent suction event (Daily alarm)

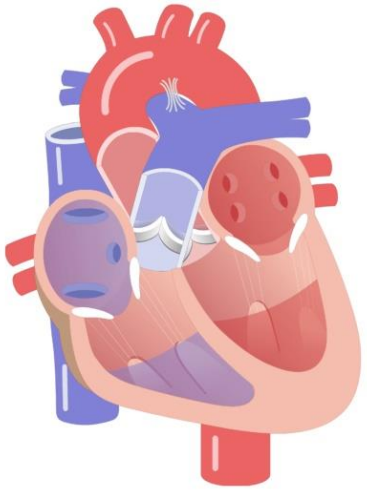


6 weeks after Vanco + Gentamicin



Heart Transplantation

(1 year and 6 months after BTT LVAD)

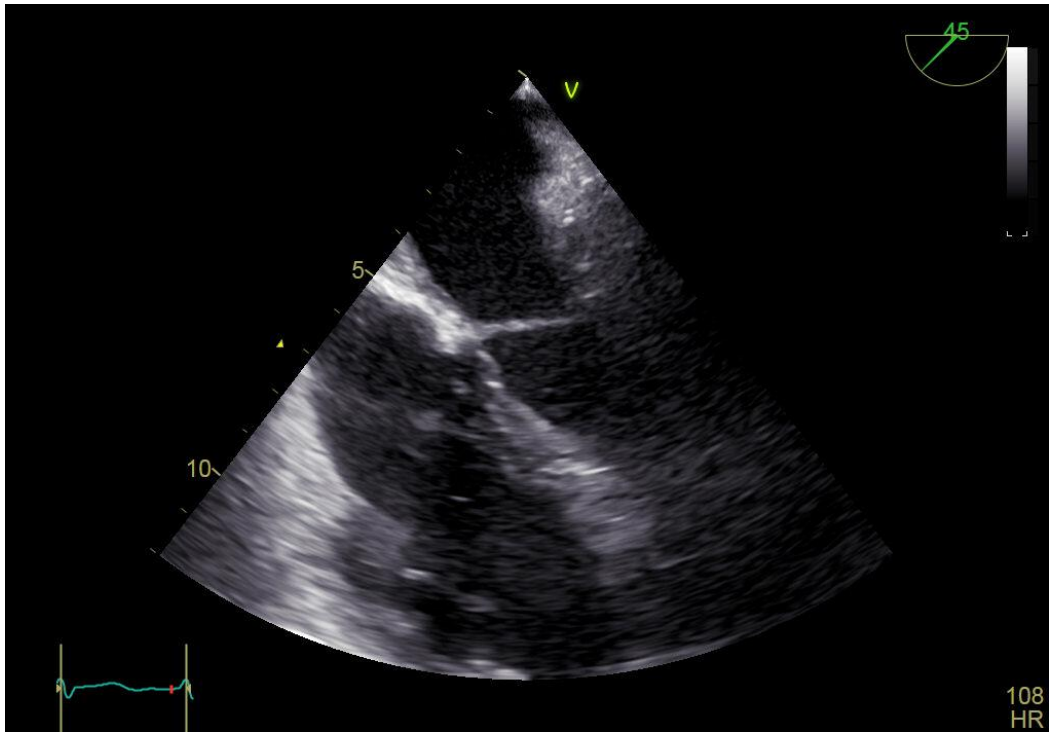


Donor matched

18 yo Male

185cm, 100kg

XM (negative)



Intra OP TEE

Recipient status

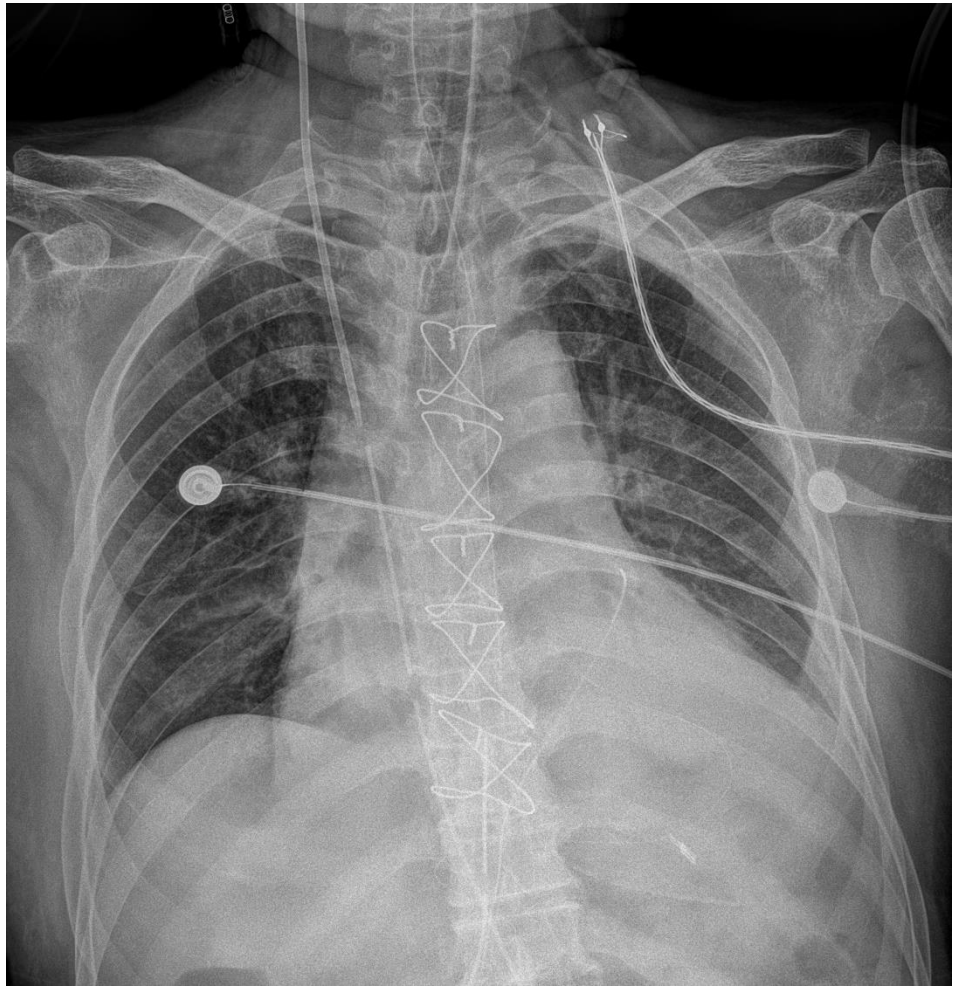
160cm, 60kg, PHMr 1.85, Wtr 1.67

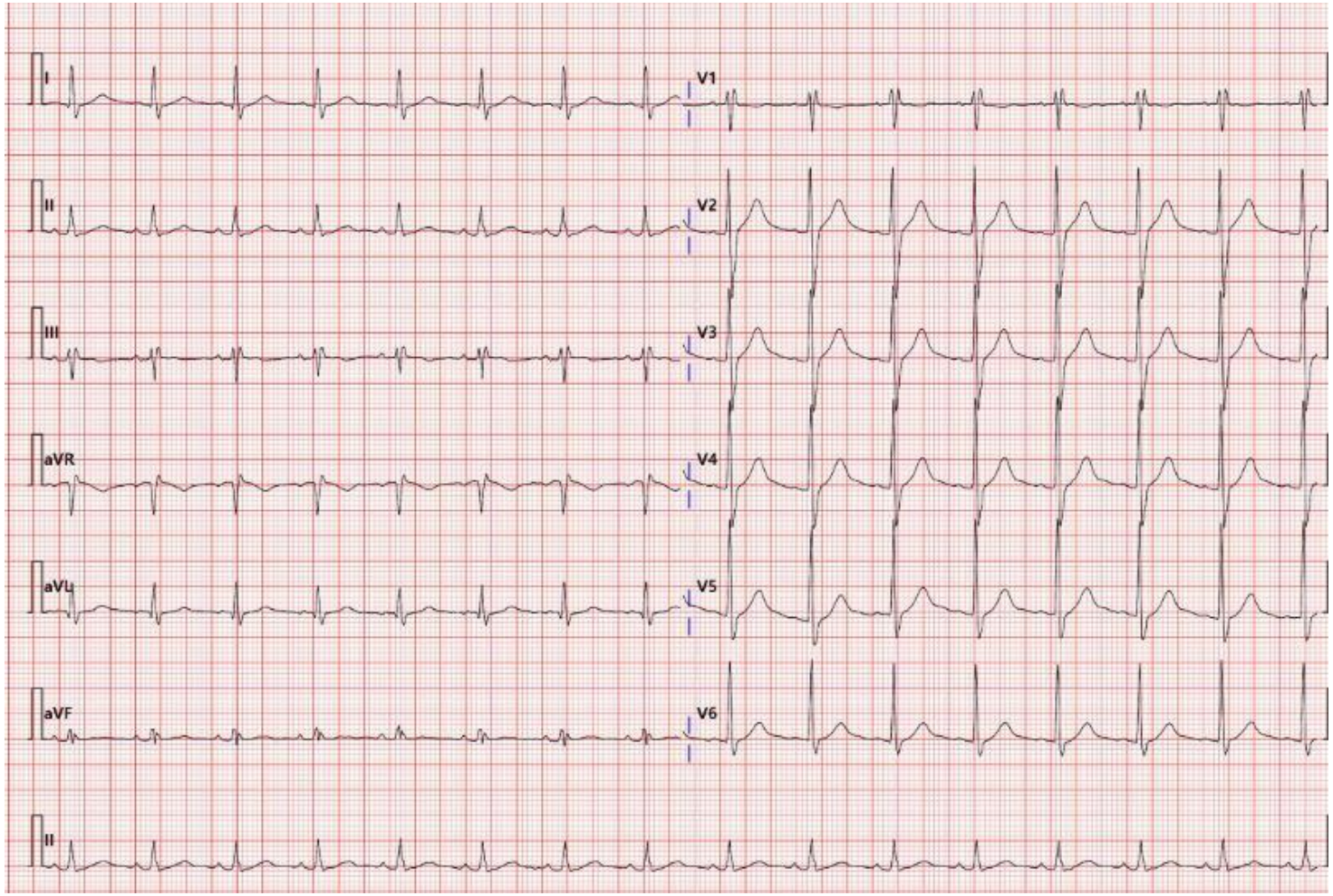
LVAD parameters

RPM 2540, Flow 3.5L, 3.4 Watts

MBP 80

Immediate Post-OP





Immediate Post-OP

Lactic acid	3.4	12.2	13.9	17	19	21	22	22

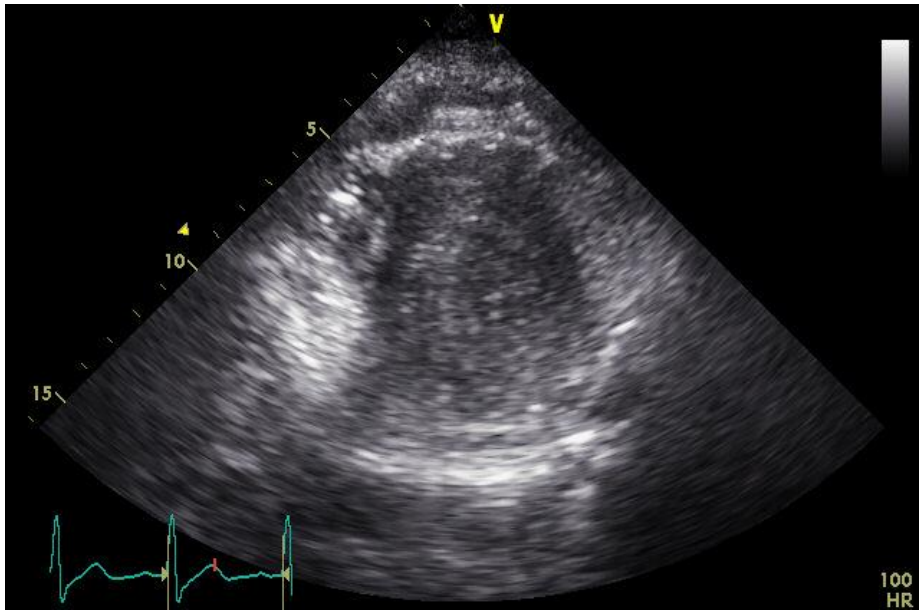
항목	동기	13:10	16:00	16:40	17:36	23:01	23:36	00:20	01:05	01:13	01:20	01:28	01:35	01:40	01:50	02:00	02:05	02:35	02:40	03:00	03:05	03:10	03:35	03:48	04:00	04:05	04:10	04:40	04:55	05:00	05:25	05:55	06:00	06:10	06:15	06:23	06:28	06:35	06:40	06:50	06:51
Remark																																								
Remark		입원							수술																																
활력징후																																								
BT (℃)		36.7	36.5	36.6					36.0		36.0		36.0		36.0		36.0	36.0			36.0		36.0		36.0	36.0		36.0	36.1		36.8	36.5	36.8		36.8			36.8		36.8	36.8
PR (회/min)		72	62	65					90		98	96	94	93	94	102	107	101	152	97	100	100	101		103	105		112	108	110	107	111	109	109	107	108		110	111	117	117
RR (회/min)		19	18	20					21		15	16	18	19	18	20	21	15	14	12	17	16	18		20	21		24	22	27	23	28	27	25	26	24		20	20	19	19
SBP (mmHg)		107	105	110																								121	119		100	108			83			86		64	61
DBP (mmHg)		81	80	70																								40	40		35	38			34			40		40	39
ISBP (mmHg)									121		122	89	90	80	92	143	129	116	115	115	113	112	113		100	98				111			96	84		80	73	86	75		
IDBP (mmHg)									70		74	58	57	46	53	53	51	66	46	44	40	39	38		35	34				38			36	34		34	32	40	20		
IMBP (mmHg)									90		86	69	70	56	69	72	68	63	52	61	59	54	52		47	47				53			47	44							
SpO2 (%)		98	97	97					100		100		100		100	100	100	100		100	100		98		98	98				97			96			95	94	95			
EKG																			V-tac																						
EpinePHrine Inj 1mg/1ml/A (epinephr...	Epi								S-10			>12				>15				>14		>15			15					15			15								
Norpin Inj 10mg/10ml/A (norepineph...	Norepi								S-10			>12				>10				10					10					10			10								
Albumin 5% 12.5g/250ml/BT (human...												S250E						S-100		100		50E						S250E													
TroPIN Inj 400mg/5ml/A (dopamine)	Dopamine													S-10		10				10					10					10			10								
Sodium Bicarbonate Inj 8.4% 1.68g/2...																S-20				>40					40					40			40								
Primacor Inj 10mg/10ml/A (milrinone)	Milrinone																			S-2.5	>3				3					3			3								

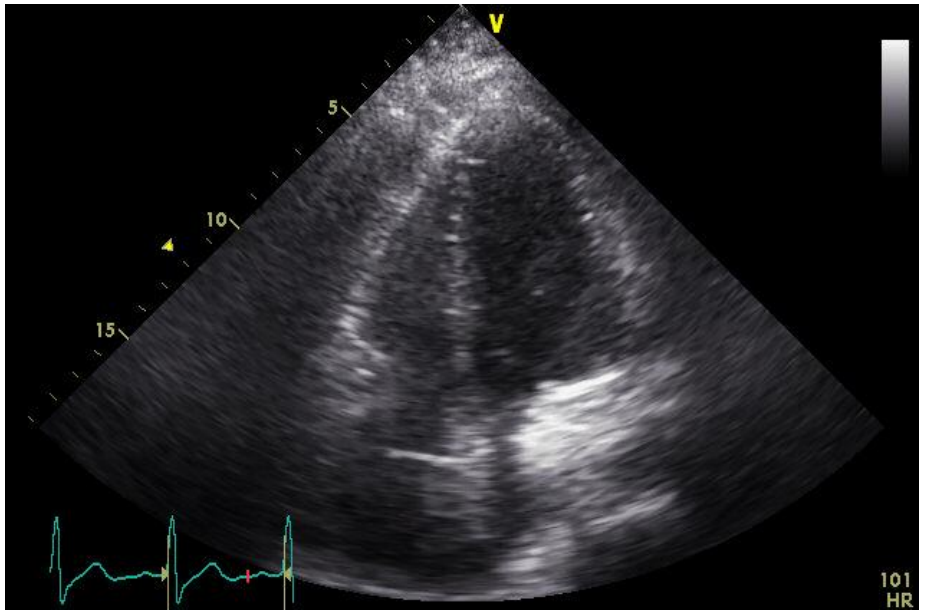
CCU out

ECMO

Immediate Post-OP

ECMO insertion

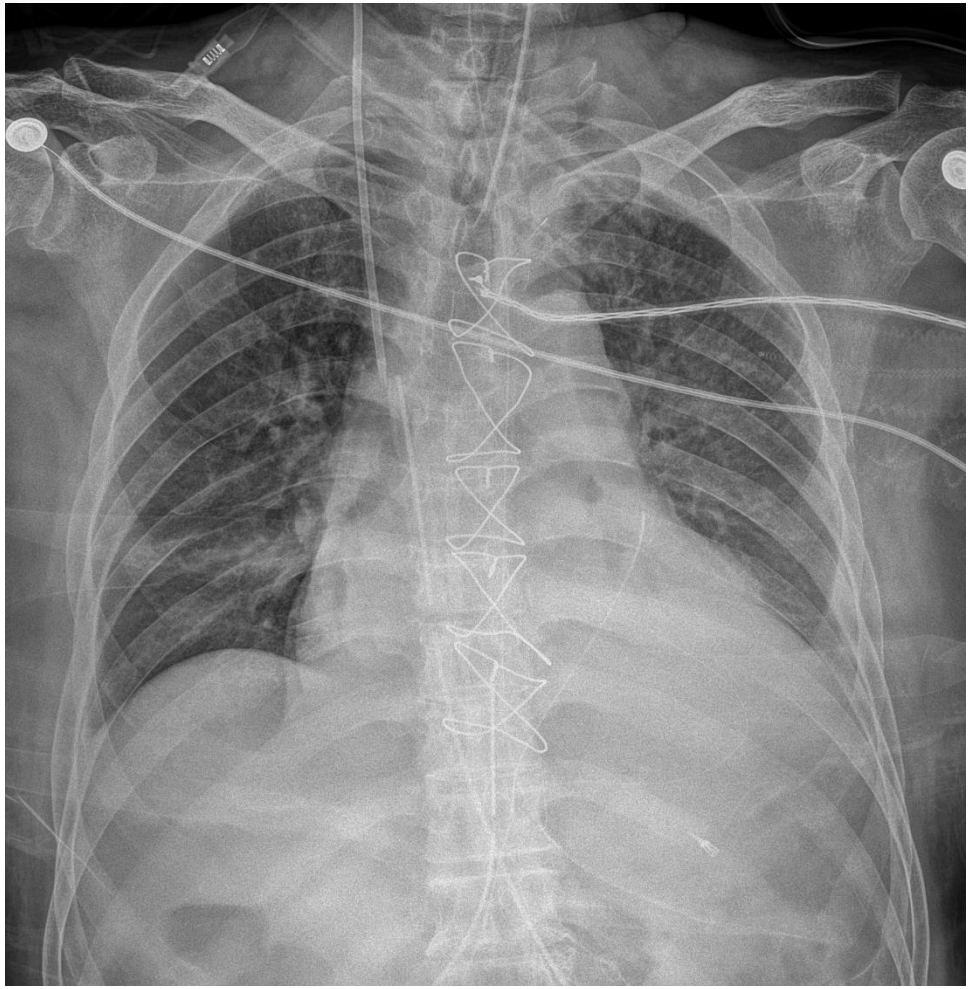


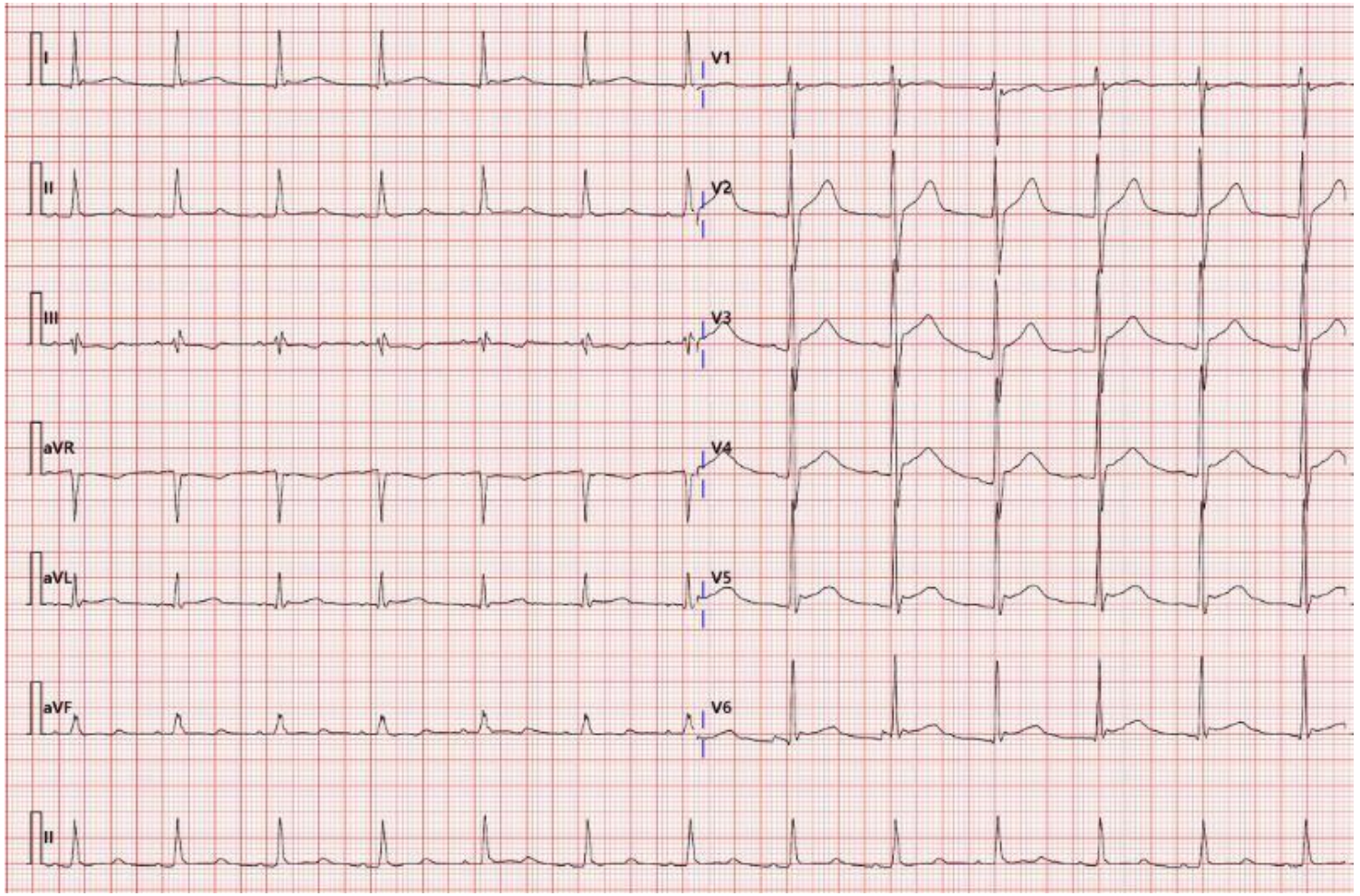


Pre-ECMO

Post-ECMO

Post-ECMO





Immediate Post-OP

Lactic acid 22 20 18 13.9 7.1 2.8

항목	동기	06:51	07:00	07:52	08:00	09:00	09:30	09:45	10:00	10:44	11:00	11:05	11:15	11:45	12:00	12:30	12:45	12:50	13:00	13:10	13:20	13:25	13:40	13:45	14:00	14:05	14:15	14:45	14:50	15:00	15:01	15:07	16:00	16:45	17:00	17:50	18:00	18:10	19:00	19:49	20:00
Remark																																									
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활력징후																																									
BT (℃)		36.8	36.1		36.1		36.1	35.8	35.8			35.1	35.1	35.1	35.1	35.1		35.0			35.3	35.3	35.4	35.6		35.5	35.3	35.4	35.5		35.5			35.5			35.8		
PR (회/min)		117	112	104	103	101	99	100	97	93	91	92	92	93	92	97	85	91	95	95	95	95	97	91	94	95	97	93	92	91	94	89								
RR (회/min)		19	17	13	17	21	14	15	16	15	15	15	15	15	15	15	15	15	15	14	15	15	15	15	15	15	15	15	15	15	15	15								
SBP (mmHg)		61		54			73	80					76	74	80	107				85	87	88	89	85	84	85													
DBP (mmHg)		39		37			45	47					47	45	49	55				54	54	56	55	58	53	57													
ISBP (mmHg)			53		63	63			78	68	69	71		73			120	87	79				87				93		95	88	98	93	98							
IDBP (mmHg)			36		39	41			47	45	42	45		46			56	52	54				55				58		59	63	69	70	73							
IMBP (mmHg)			39		44	45			53	49				51				59					61				65		67	68	75	75	78							
SpO2 (%)			100		100	100			100	100	100			100				100					100				100		100	100	100	100	100							
EKG																																V-tac								
EpinePHrine Inj 1mg/1ml/A (epinephr...			>10		10	10			10	10				10			>8	>10	>12				12				12		>10	>9	9	>8	S>7	>6						
Norpin Inj 10mg/10ml/A (norepineph...			10		10	10			10	10				10				10					10				10		10	10	10	10	S-10	10						
Albumin 5% 12.5g/250ml/BT (human...			s250e																	s250e																				
TroPIN Inj 400mg/5ml/A (dopamine)			10		10	10			10	10				10				10					10				10		10	10	10	10	S-10	10						
Sodium Bicarbonate Inj 8.4% 1.68g/2...			S3 20		20	20			20	20				20				>10					10				10	H												
Primacor Inj 10mg/10ml/A (milrinone)			H																																					
Vasopressin Inj 20IU/1ml/A (vasopres...					3				>2	2				2				2					2				2		2	2	2	2	2	2						

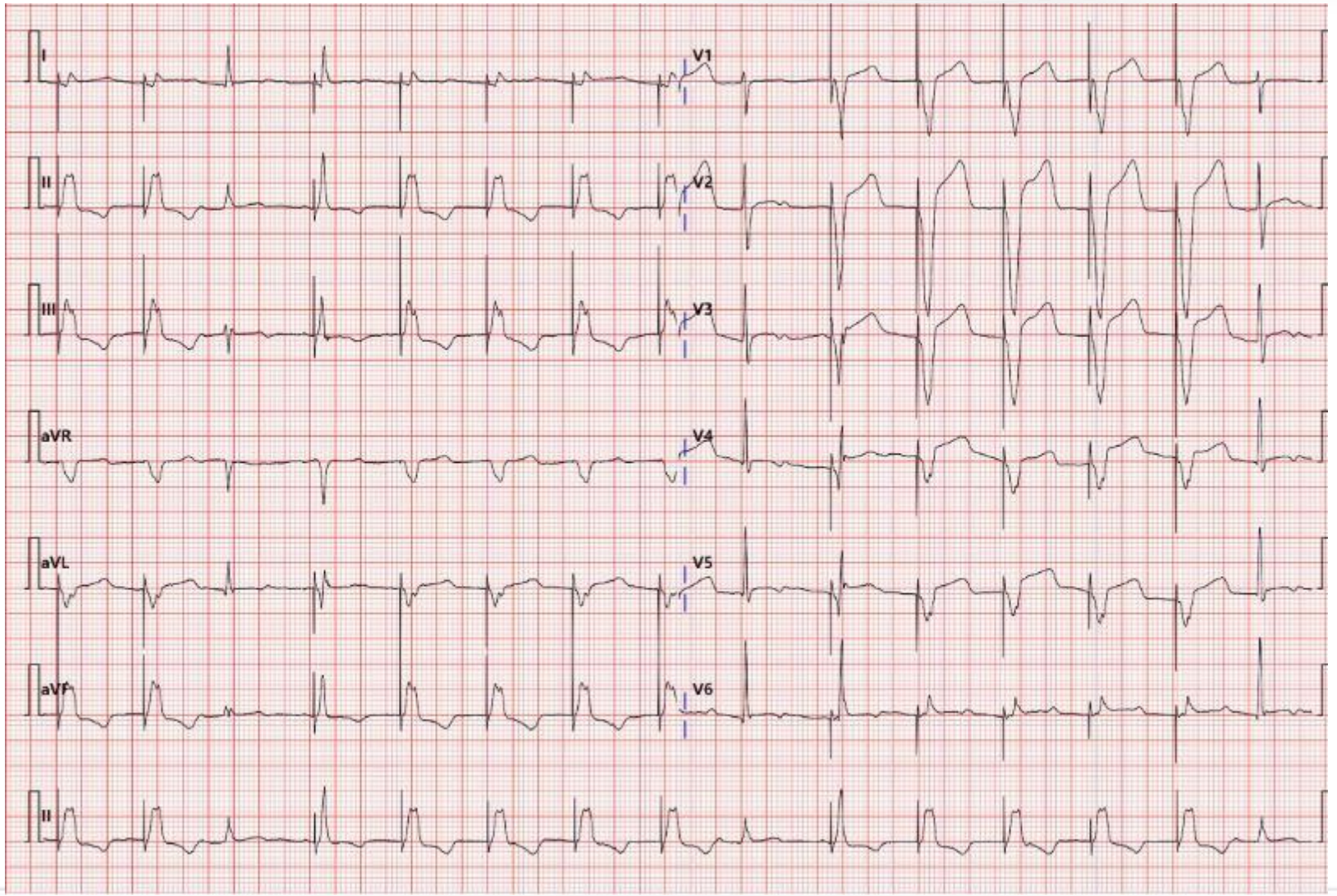
Epi

Norepi

Dopamine

Vasopressin

During ECMO



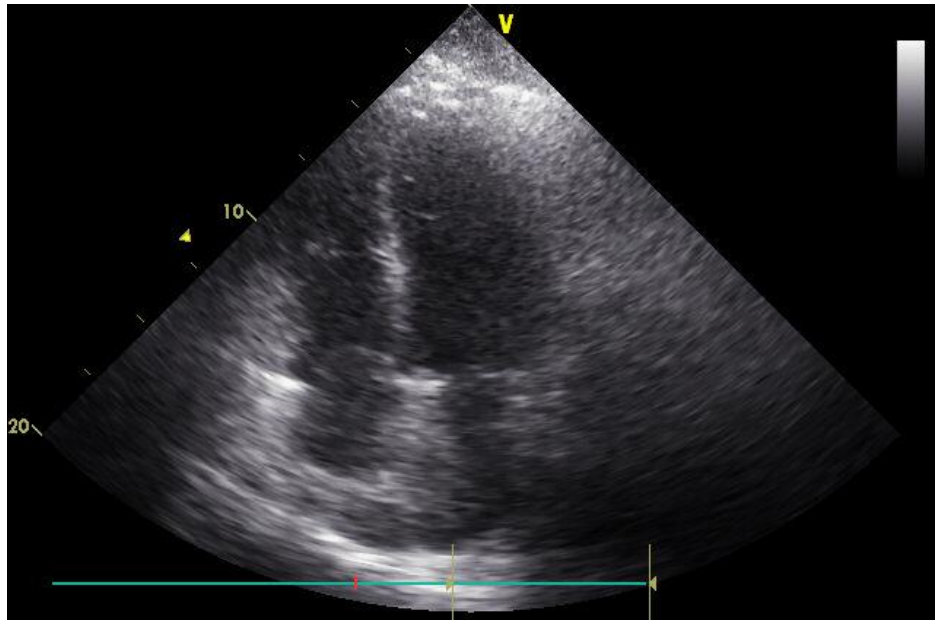
Hospital course

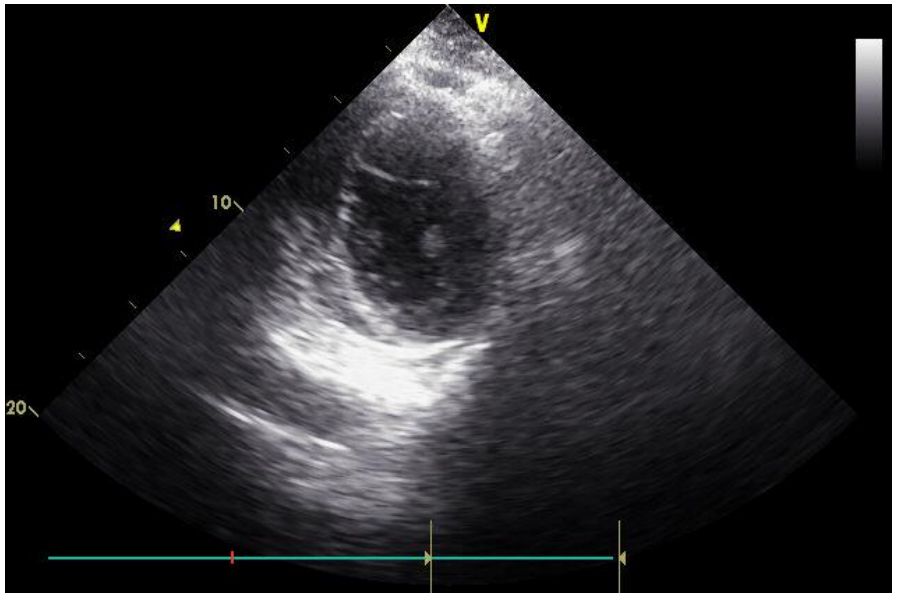
POD1
Vasopressin D/C

POD2
Epinephrine D/C

POD4
NE D/C

POD5
ECMO weaning



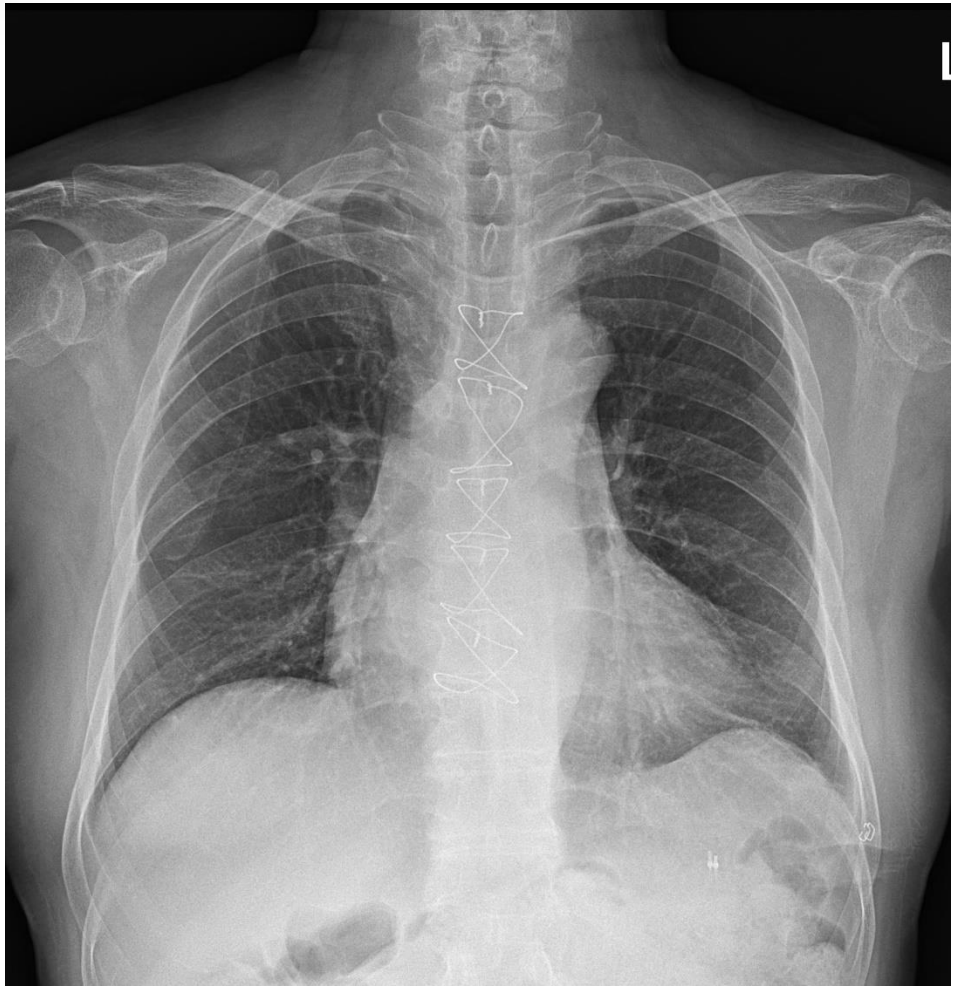


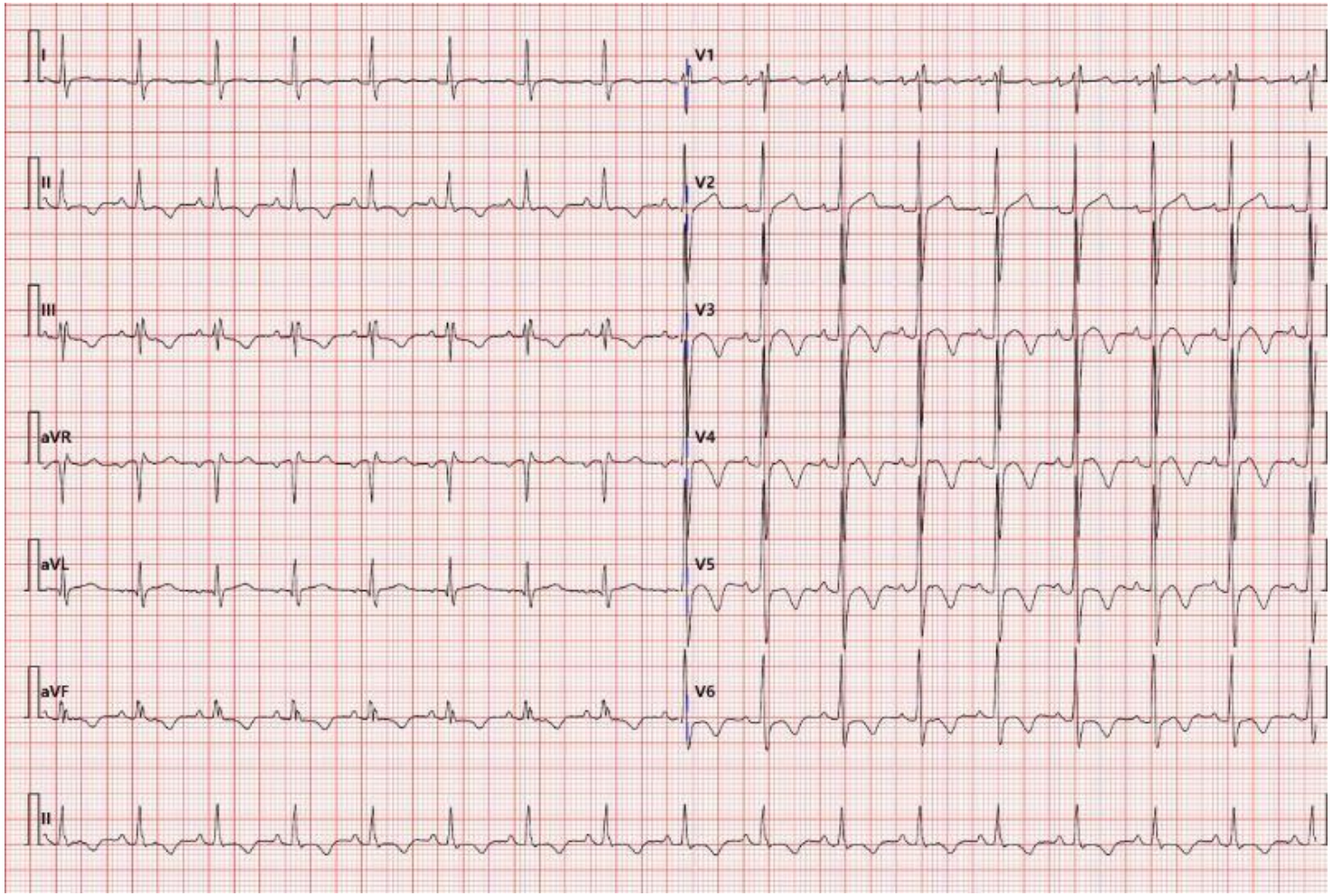
Post ECMO Weaning TTE

Hospital course

- **Ventilator weaning at POD 6**
- **Transfer to general ward at POD 10**
- **Discharge at POD 27**

Discharge

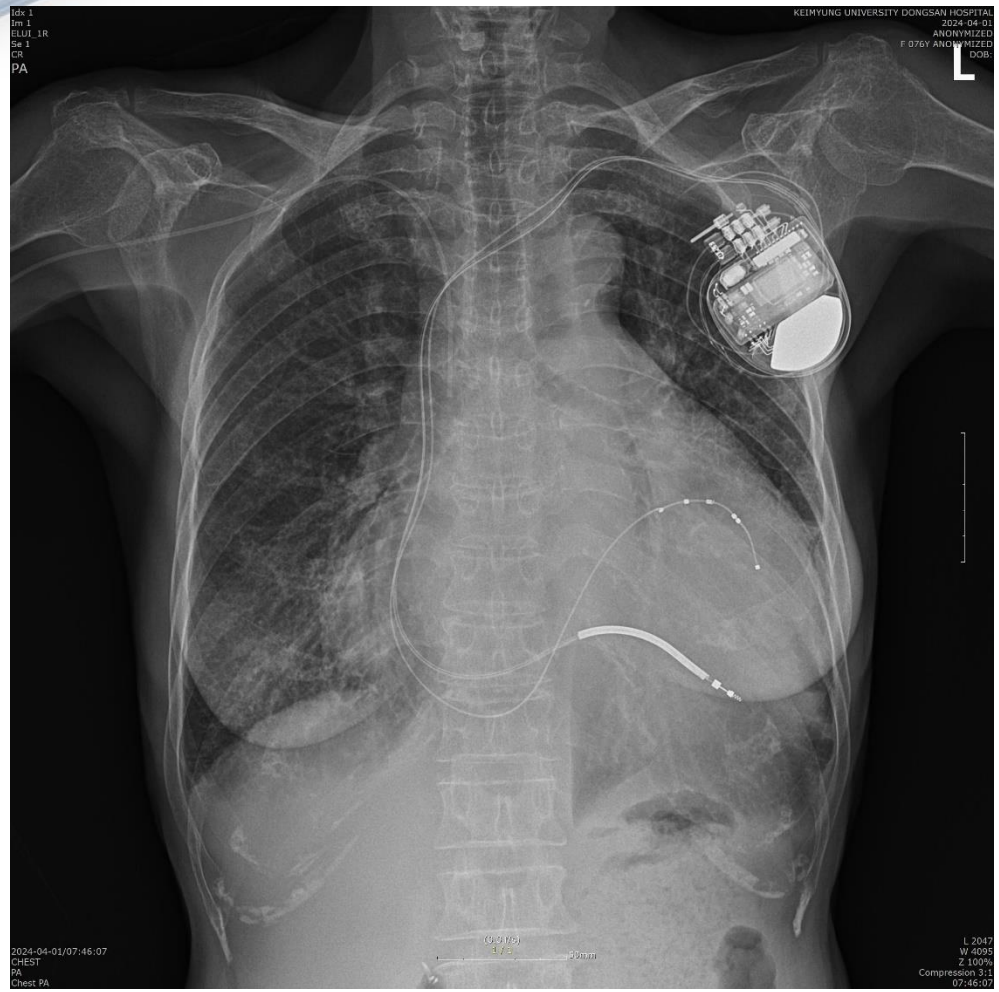




Lessons from the Case

- **Size mismatch is an important risk factor for PGD**
- **Use of inotropic / chronotropic treatment should be personalized based on the patient situation**
- **Appropriate use of MCS need to be considered in need of high-dose inotropics**

76 years old / Female (Rh+ B)



149 cm/47kg

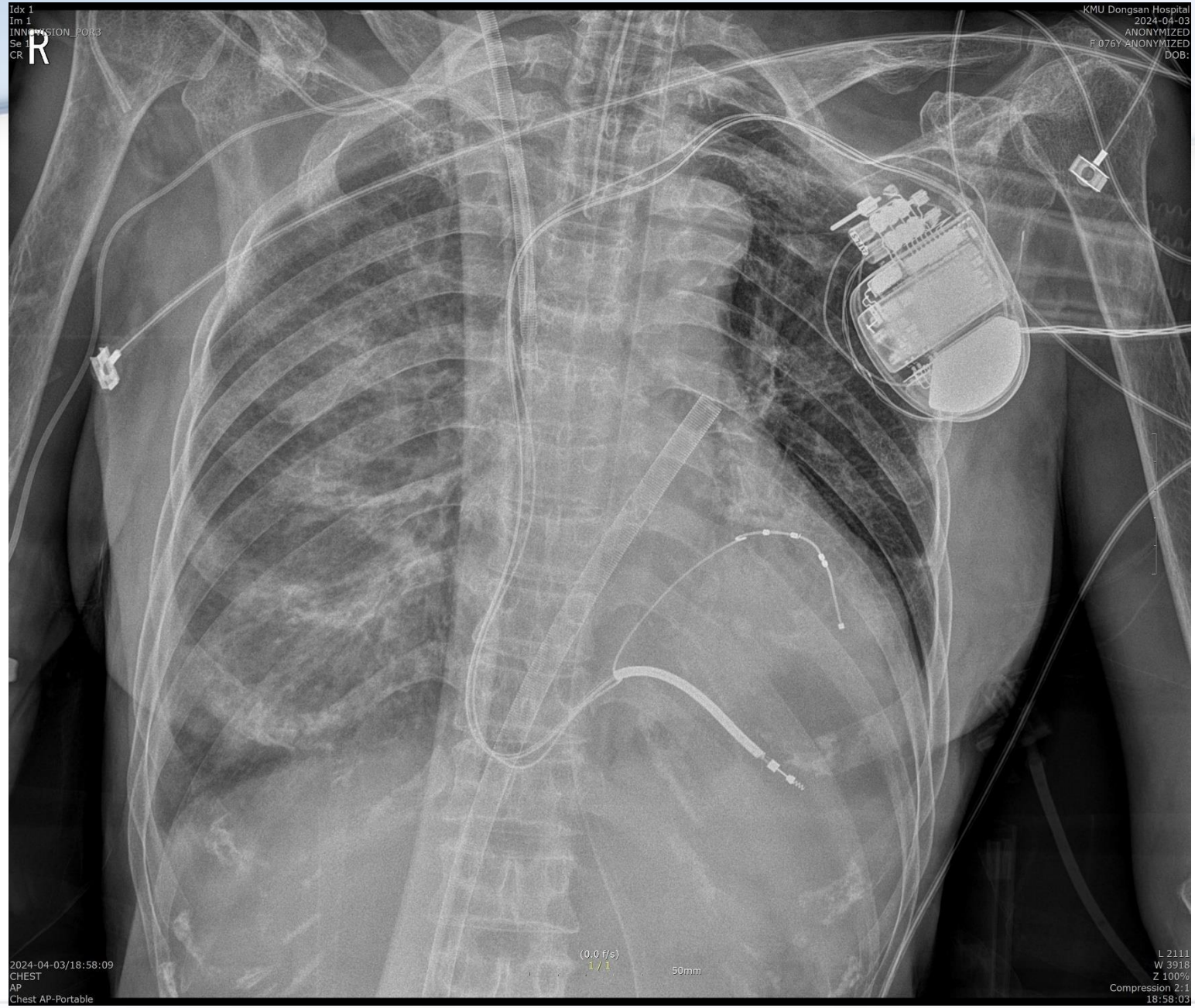
HFrEF (EF 16%)

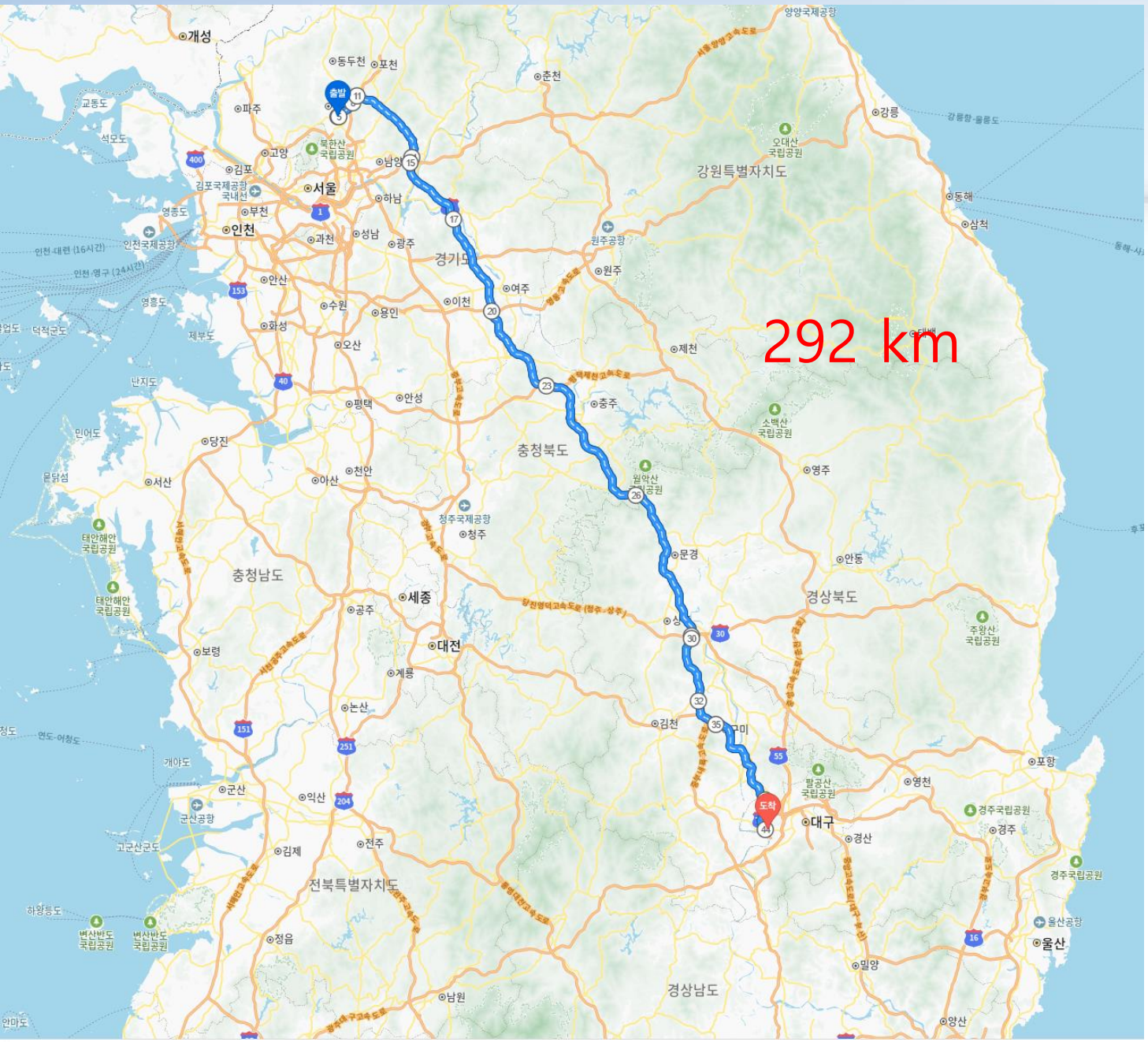
Non-Ischemic CMP, idiopathic DCM

Post ROSC, VT arrest (2022.10.16)

s/p ICD insertion (2022.10.17)

HF aggravation →ECMO insertion (2024.4)


Idx 1
Im 1
INNOVISION_POR3
Se 1
CR
R
KMU Dongsan Hospital
2024-04-03
ANONYMIZED
F 076Y ANONYMIZED
DOB:
2024-04-03/18:58:09
CHEST
AP
Chest AP-Portable
(0.0 f/s)
1 / 1
50mm
L 2111
W 3918
Z 100%
Compression 2:1
18:58:03



- Heart Transplantation
  - Cold ischemic time
    - 216 min
  - Warm Ischemic time
    - 30 min

- CPB weaning difficulty
  - RV dysfunction

- OR out after ECMO insertion

항목 (비동기)	06:35	07:00	07:25	08:00	08:20	09:00	09:30	10:00	10:30	10:31	11:00	12:00	13:00	14:00	15:00	15:30	15:57	21:00	21:21	22:25	22:37	22:40	22:55	23:00	23:10	23:25	23:40	23:45	23:50
BT (℃)		35.0		34.8		34.3		34.3			34.2	34.3	34.2	34.3	34.2	34.2				34.2		34.3	34.2	34.2	34.3		34.2	34.2	
PR (회/min)	73	62		67	63	61	67	64			61	66	62	67	73	72				79		71	72	71	70		66	60	59
RR (회/min)	15	15		15	15	15	15	15			15	21	15	15	15	15				15		17	15	15	16		17	15	15
SBP (mmHg)																												113	
DBP (mmHg)																												75	
ISBP (mmHg)	60	82		89		96	108	103			100	98	92	89	97	82				96		94	119	115	118		116		110
IDBP (mmHg)	56	78		86		93	100	99			96	96	89	86	93	84				72		70	80	78	80		78		74
IMBP (mmHg)	57	80		85	88	94	101	101			98	67	91	87	94	89				80		78	93	90	92		90		83
SpO2 (%)		100		100		100		100			100	100	100	100	100	100				100		100	100	100	100		100		
▾ 신체계측																													

항목 (비동기)	06:35	07:00	07:25	08:00	08:20	09:00	09:30	10:00	10:30	10:31	11:00	12:00	13:00	14:00	15:00	15:30	15:57	21:00	21:21	22:25	22:37	22:40	22:55	23:00	23:10	23:25	23:40	23:45	23:50
C-tube Med 1 (cc)																								20					
C-tube Med 2 (cc)																								20					
▾ 혈당																													
BST (mg/dl)										123							103	94	104		113								
▾ 약물																													
DoBUTamine Premix 500mg/250ml/b...		10		10		10		10			S-10	10	10	10	10					S-10		>8		8					
Dextomine Premix 400mcg/100ml/BT...		7		7		7		7			7	>8	8	8	8	H													
EpinePHrine Inj 1mg/1ml/A (epinephr...		3		3		S>5		5			5	5	5	5	5					S-5				5					
Eglandin Inj 10mcg/2ml/A (alprostadil)		10		10		10		10			S-10	10	10	10	10	H													
Plasma SOLution A 1,000ml/bag		30		30		30		30			E																		
Ultian Inj 5mg/V (remifentanil)		S1-7		7		7		7			7	>8	8	S2-8	8					S3-4				4					
Smofkabiven Inj 986ml/bag		30		30		30		30			30	30	30	30	30	H													
Heparin Inj 25,000IU/5ml/V (heparin)		1		1		1		1			S-1	1	1	1	1	E													
Norpin Inj 10mg/10ml/A (norepineph...	>8	8		8	>7	S>7	>6	>3	>2		2	>1	1	1	1	H				S-3				>2					
Plasma LYte 148 1,000ml/bag											S-30	30	30	30	30														

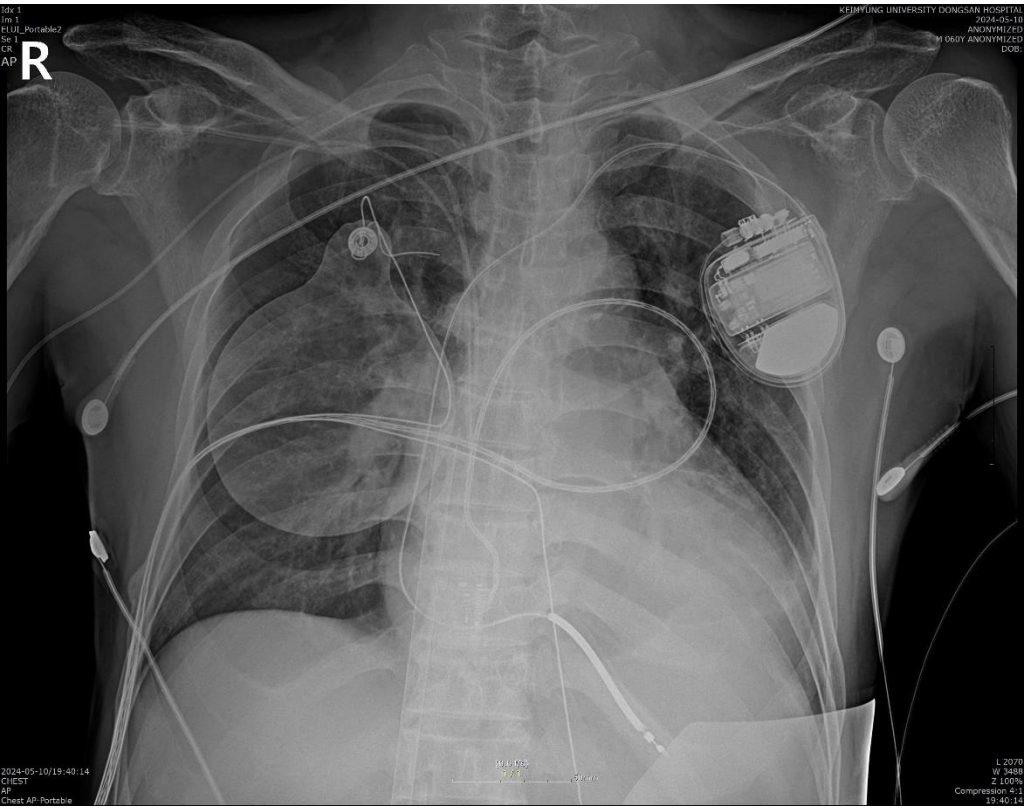
항목 비동기	00:00	00:10	00:30	01:00	01:10	01:30	02:00	02:30	02:45	03:00	04:00	04:59	05:00	06:00	07:00	07:45	08:00	08:15	08:30	09:00	09:15	09:30	10:00	10:19	11:00	11:30	12:00	12:20	1
활력징후																													
BT (℃)	34.2	34.2	34.3	34.2	34.2	34.3	34.3	34.1	34.2	34.1	34.2		34.2	34.5	34.3	34.1	34.1		34.2	34.9		35.3	36.0		36.3		36.5		
PR (회/min)	90	90	90	90	90	90	90	90	90	90	90		90	90	90	90	90	70	90	71	70	70	73		69		71		
RR (회/min)	15	17	14	12	14	14	15	15	16	15	15		23	16	15	15	15		15	15		15	15		15		15		
SBP (mmHg)	103		112	113	115	116	100	99	100							94	96		98	90		98	97						
DBP (mmHg)	75		79	81	83	82	74	72	71							65	65		62	60		61	61						
ISBP (mmHg)	105	109		115	116		99			98	94		89	85	87		98			88	80		89		88		118	139	
IDBP (mmHg)	77	78		81	81		73			72	70		70	64	62		67			58	52		58		56		68	98	
IMBP (mmHg)	85	87		91	92		81			80	77		76	71	69		76			68	65		68		66		81	96	
SpO2 (%)	100	100		100	100		100			100	100		100	100	100		100			100			100		100		100		
EKG																		self...					NSR				NSR		
신체계측																													

약물																													
5% D/W 500ml/bag	20			20			20		E																				
DoBUTamine Premix 500mg/250ml/b...	8			8			8		S-8		8		8	8		8	8			8	8	8	8		8	8		8	
EpinePHrine Inj 1mg/1ml/A (epinephr...	5				>8		8		S-8		8		8	>5		5	5			5	5	5	5		5	5		5	
Plasma SOLution A 1,000ml/bag	40			40			40		S-40	>200	>40		40	40	H														
Ultian Inj 5mg/V (remifentanil)	4			4			S1-4		4	>2	2		2	2		2	2			2	2	2	2		2	2		2	
Norpin Inj 10mg/10ml/A (norepineph...									S-3		3	H																	
Eglandin Inj 10mcg/2ml/A (alprostadil)	10			10			10		10		10		10	10		10	10			10	10	10	10		10	10		10	
Smofkabiven Inj 986ml/bag									S-40		40		40	40		40	40			40	40	40	40		40	40		40	
Albumin 20% 20g/100ml/BT (human...							>30		30		20E																		
Binicapin Inj 20mg/20ml/A (nicardipine)																		S-2		2	2	>1	1		1	1		1	
Lasix Inj 20mg/2ml/A (furosemide)																						S-2	2		2	2		2	

검사명	2024-04-06	2024-04-06	2024-04-06	2024-04-05	2024-04-05	2024-04-05	2024-04-05	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	2024-04-04	202
Lactic acid (	2.6	2.5	2.3	2.6	2.0	1.4	1.5	2.0	1.4	2.6	2.2	2.0	1.7	1.7	1.3	2.3	1.0	1.3	1.0	1.0	

- POD#4 ECMO removal

60 years old / Male (Rh+ B)



166 cm/62kg

HFrEF (EF 17%)

Ischemic CMP

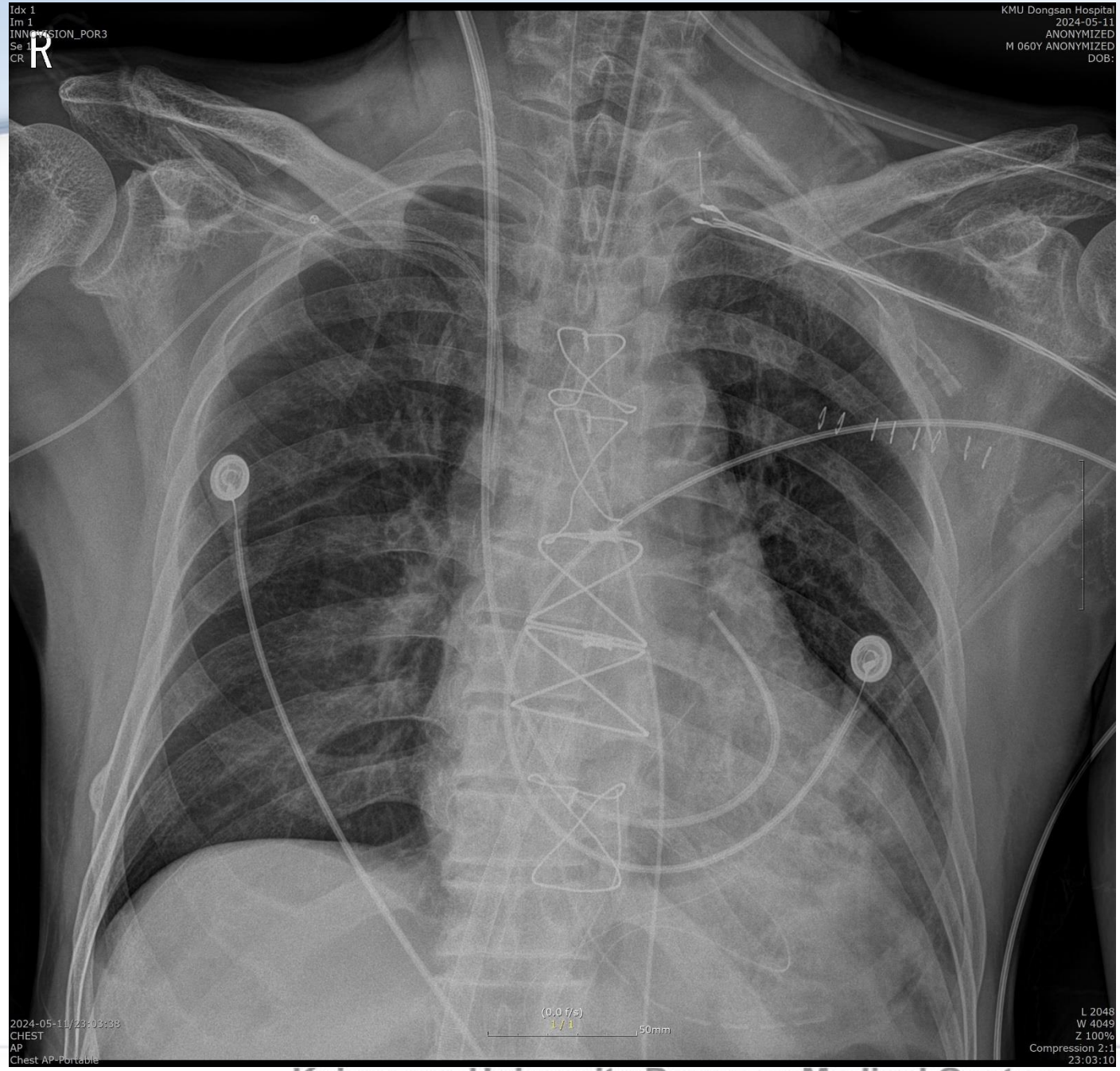
Cardiac arrest s/p ECMO insertion (4 days)

s/p ICD insertion

Extubation후 HF management

ECMO reinsertion

- Heart Transplantation
  - Cold ischemic time
    - 170 min
  - Warm ischemic time
    - 58 min
- Weaning try
  - BP tolerable
  - Femoral a wave form
  - Previous 두차례 ECMO insertion Hx
- ECMO insertion후 OR out


Idx 1
Im 1
INNOVISION_POR3
Se 1
CR
R
KMU Dongsan Hospital
2024-05-11
ANONYMIZED
M 060Y ANONYMIZED
DOB:
2024-05-11 23:03:38
CHEST
AP
Chest AP-Portable
(0.0 f/s)
1 / 1
50mm
L 2048
W 4049
Z 100%
Compression 2:1
23:03:10

- POD#0 LV function 저하
- POD#5 ECMO weaning

Cause of Shock after HTx

- **Primary Graft Dysfunction**
- **Secondary Graft Dysfunction**
  - **Hyperacute rejection**
  - **Pulmonary HTN**
  - **Surgical complications (bleeding)**
- **Post-OP vasoplegia**
- **Bradycardia / Conduction abnormalities**

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Primary graft dysfunction

1. PGD-Left ventricle (PGD-LV):	*Mild PGD–LV*: *One* of the following criteria must be met:	LVEF $\leq$ 40% by echocardiography, *or* Hemodynamics with RAP $>$ 15 mm Hg, PCWP $>$ 20 mm Hg, CI $<$ 2.0 L/min/m^2 (lasting more than 1 hour) requiring low-dose inotropes
	Moderate PGD-LV: Must meet one criterion from I *and* another criterion from II:	I. *One* criteria from the following: Left ventricular ejection fraction $\leq$ 40%, *or* Hemodynamic compromise with RAP $>$ 15 mm Hg, PCWP $>$ 20 mm Hg, CI $<$ 2.0 L/min/m^2, hypotension with MAP $<$ 70 mm Hg (lasting more than 1 hour) II. *One* criteria from the following: i. High-dose inotropes—Inotrope score $>$ 10[a] *or* ii. Newly placed IABP (regardless of inotropes)
	Severe PGD–LV	Dependence on left or biventricular mechanical support including ECMO, LVAD, BiVAD, or percutaneous LVAD. Excludes requirement for IABP.
2. PGD-right ventricle (PGD-RV):	Diagnosis requires either both i and ii, or iii alone:	i. Hemodynamics with RAP $>$ 15 mm Hg, PCWP $<$ 15 mm Hg, CI $<$ 2.0 L/min/m^2 ii. TPG $<$15 mm Hg and/or pulmonary artery systolic pressure $<$ 50 mm Hg, *or* iii. Need for RVAD

BiVAD, biventricular assist device; CI, cardiac index; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; LVAD, left ventricular assist device; PCWP, pulmonary capillary wedge pressure; RAP, right atrial pressure; RVAD, right ventricular assist device; TPG, transpulmonary pressure gradient.

[a]Inotrope score = dopamine (×1) + dobutamine (×1) + amrinone (×1) + milrinone (×15) + epinephrine (×100) + norepinephrine (×100)[67] with each drug dosed in μg/kg/min.

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Primary graft dysfunction

	(1/1/2005–1/1/2012)	
Cedars-Sinai Heart Institute[a]	8/555	Cedars-Sinai approach to PGD in the OR

Maximize inotrope

↓

IABP

↓

ECMO

1. Exclude anatomic problems (i.e., anastomosis narrowing or kinking)
2. Maximize inotropic support in the OR with max dose of milrinone (0.5 µg/kg/min), epinephrine (0.08–1 µg/kg/min), and dopamine (5 µg/kg/min).
3. IABP if CI remains < 2.5 L/min/m^2 with CVP and LAP of > 12 mm Hg and MAP $<$ 65 mm Hg despite #2
4. Place on ECMO if CI remains < 2.5 L/min/m^2 with CVP and LAP >12 mm Hg and MAP < 65 mm Hg despite #3. Cannulate aorta and right atrium through the chest wall or upper abdominal wall so the sternum can be closed
5. Maintain a cardiac index of 2.5 L/min/m^2 while on ECMO and reduce inotropic support to minimal level so the heart can still eject.
6. Consider placing an LV vent via right superior pulmonary vein or LV apex to decompress the LV or switch the IABP to Impella 2.5 (Abiomed, Danvers, MA) while on ECMO if the heart does not eject.
7. No IV heparin for 24–48 hours. If no bleeding, start heparin to keep ACT at 160–180
8. Reassess myocardial function every 48 hours with TTE in addition to daily hemodynamics
9. If RV or LV improves within 5–7 days, switch ECMO to RVAD or LVAD C-Mag (Levitronix, Waltham, MA) if RV or LV is acceptable; otherwise switch to bilateral C-Mag or TAH, if lung function is acceptable, end organs are still working, and patient is a candidate for redo OHT

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Primary graft dysfunction

Table 3 Preventive Measures to Decrease Incidence of Primary Graft Dysfunction

- Donor management (addition of hormones therapy, lower inotropes)
- Better matching of donor to recipient
- Better preservation (Organ Care System, different additives in solutions)
- Gradual wean of inotropes
- Increase use of nitric oxide
- Decrease ischemic time
- Decrease transfusion requirements
- Improved procurement techniques
- Recipient selection

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Thank you
for your attention!