

# 当院での心不全マネージメント 核医学検査の有用性

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# 心不全の標準治療薬

## ■ ACE-I

(SOLVD, CONSENSUS, SAVE, AIRE, TRACE)

## ■ ARB

(Val-HeFT, CHARM-Added, VALIANT)

## ■ $\beta$ -blocker

(US Carvedilol, CAPRICORN, COPERNICUS, CIBIS II)

## ■ 抗アルドステロン薬

(RALES, EMPHASIS-HF)



# 藥物抵抗性心不全

- 高度低心機能
- 両心不全(肺高血圧)



- 低血圧
- 腎障害



# 薬物治療に加えて (当院における)

- 血行再建術＋弁形成術(IMRに対する),  
volume reduction手術
- 心筋虚血・心筋viability評価 (心臓MRI・心筋血流シンチ)
- Ablation (PV isolation)
- CRT, CRT-D
- IABP
- LVAS, 心臓移植
- 在宅酸素療法 (HOT, C-PAP, ASV; adaptive servoventilation)
- 外来点滴治療 (フロセミド・HANP・PDE-Ⅲ阻害薬)
- CKD: 透析治療 (CHDFなど); <トルバプタン?> 輸血・エリスロポエチン
- 和温療法



3D  
Ex: 17306  
Se: 104 +c  
MIP No cut Grayscale



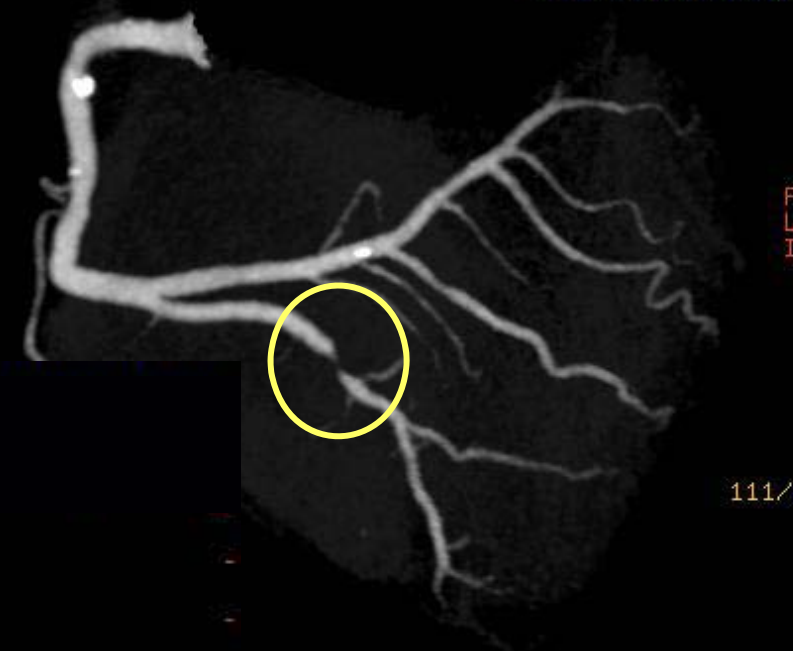
DFOV 15.0 cm  
No cut

SPR

0 L 50 LAO 30 CRA

P  
L  
I  
S  
R

DFOV 15.0 cm  
STND/C2 Ph:75% (No Filt.)



0 L 50 LAO 30 CRA

SAR

3D  
DFOV 15.0 cm  
MIP No cut

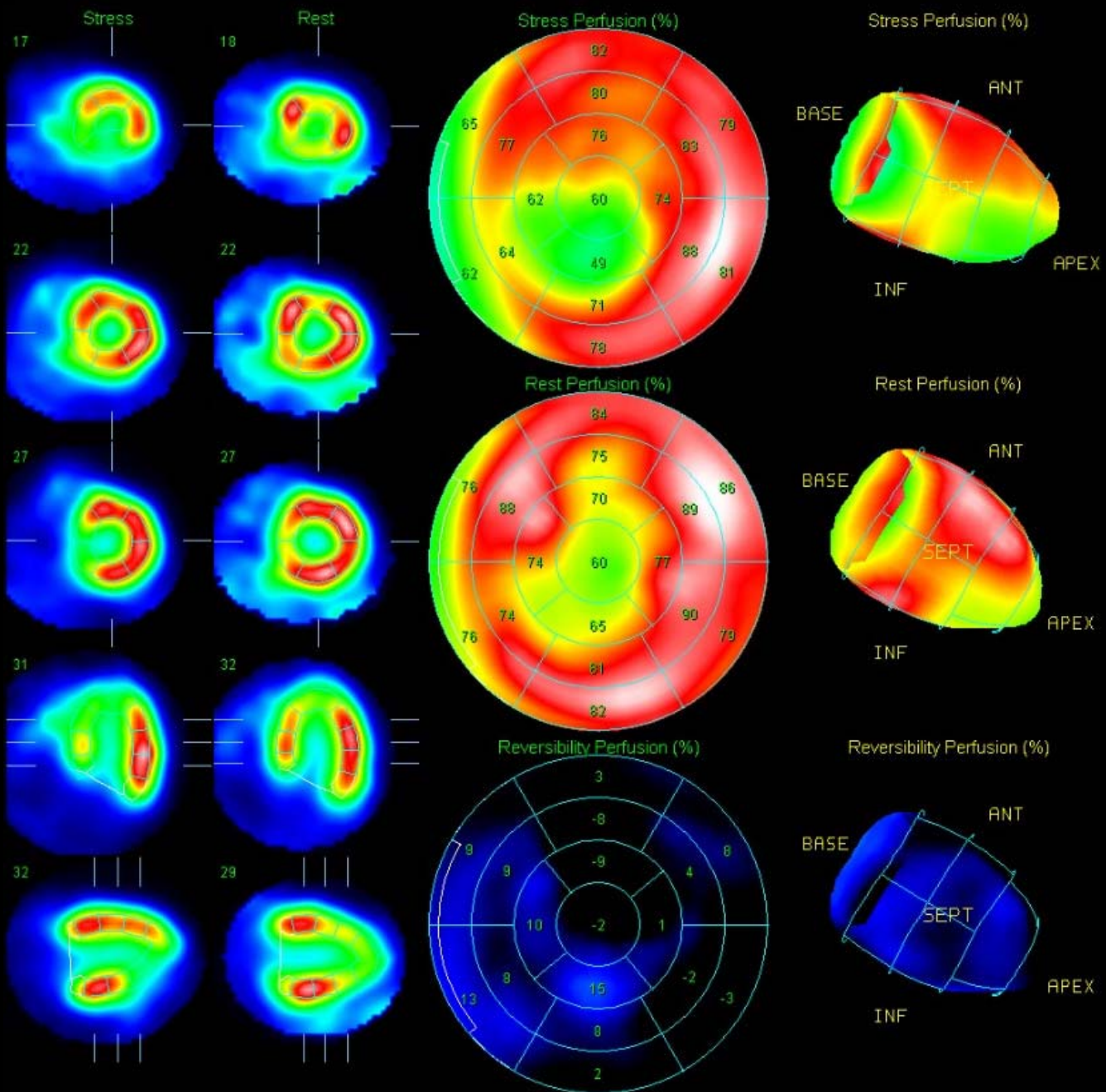
R = 733 L = 420

IAL



0 L 30 RAD 30 CAU

IAL



Surface Volume 1  
Ex: 17306  
Se: 4 +c  
Volume Rendering No cut

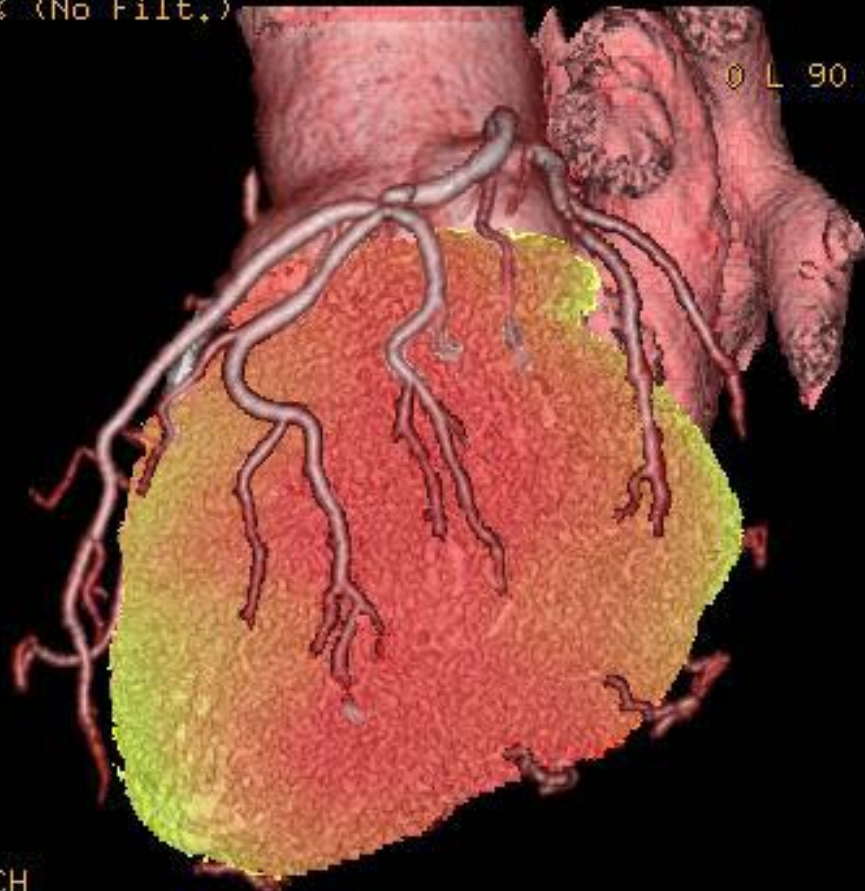
SAITAMA INTERNATIONAL MED CENT -  
I 81

DFOV 17.0 cm  
STND Ph:75% (No Filt.)

0 L 90 LAO 0 CRA

A  
7  
7

P  
9  
3



450/12

No VOI  
kv 120  
mA 480  
Rot 0.35s/CH  
0.6mm /0.6sp  
Tilt: 0.0  
03:50:36 PM  
W = 800 L = 100

I 251

-999999.000000

Surface Volume 1  
Ex: 17306  
Se: 4 +c  
Volume Rendering No cut

SAITAMA INTERNATIONAL MED CENT -  
S

DFOV 17.0 cm  
STND Ph:75% (No Filt.)

0 L 108 LAO 0 CRA -

A  
L

R  
P



No VOI  
kv 120  
mA 480  
Rot 0.35s/CH  
0.6mm /0.6sp  
Tilt: 0.0  
03:50:36 PM  
W = 800 L = 100

450/14

-999999,000000

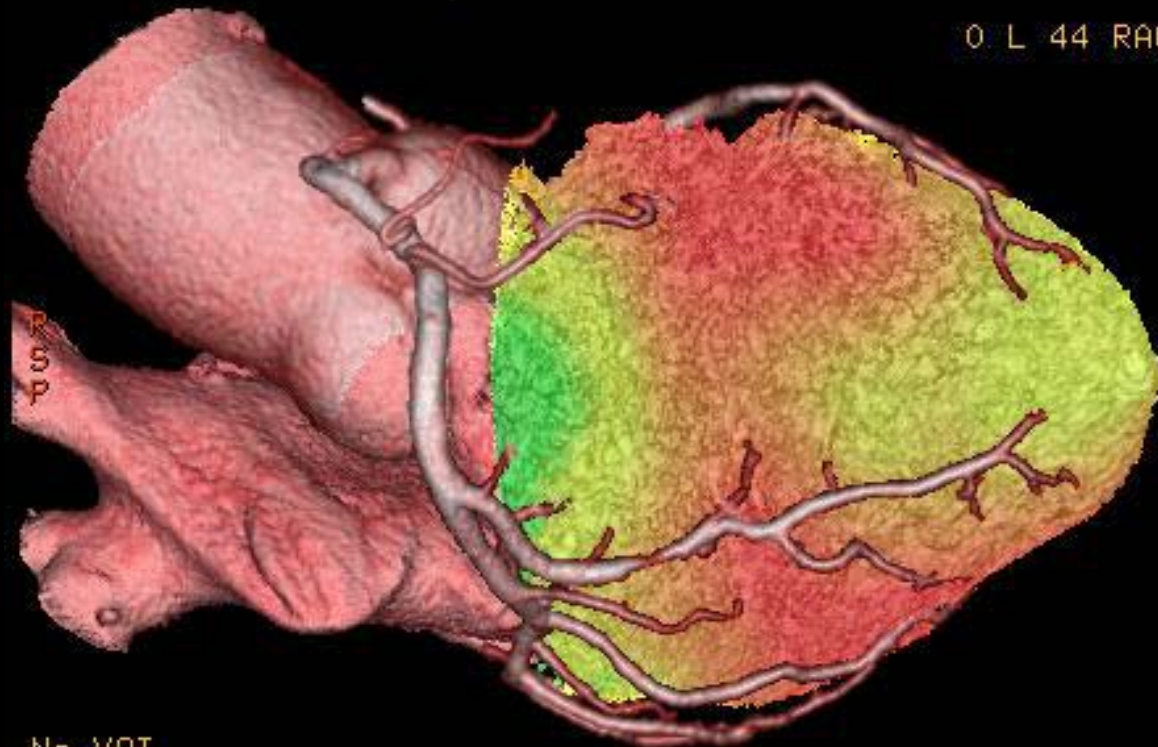


Surface Volume 1  
Ex: 17306  
Se: 4 +c  
Volume Rendering No cut

SAITAMA INTERNATIONAL MED CENT -  
ASL

DFOV 17.0 cm  
STND Ph:75% (No Filt.)

0 L 44 RAO 39 CAU -



451/7

No VOI  
kv 120  
mA 480  
Rot 0.35s/CH  
0.6mm /0.6sp  
Tilt: 0.0  
03:50:36 PM  
W = 800 L = 100

PIR

-999999.000000

## 和温療法とは

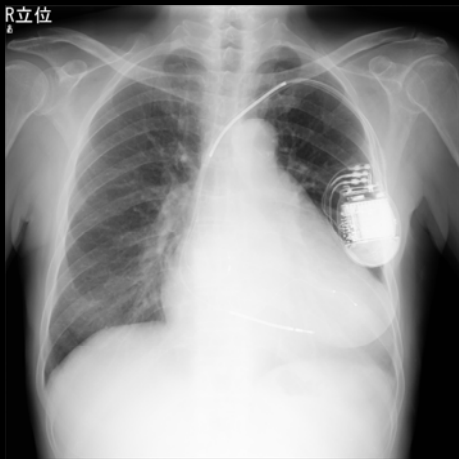
- 発汗と血管拡張による温浴効果に着目した遠赤外線均等温乾式サウナを使って心不全などを治療する温熱療法である
- [和温療法]とは、鹿児島大学病院の鄭忠和教授が命名された
- サウナで15分間加温、さらにベッドで保温30分施行する



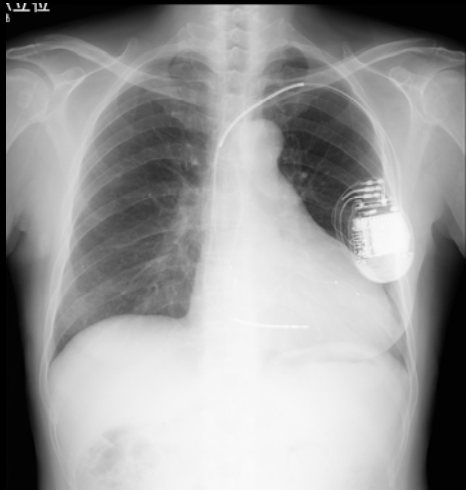
2011年2月5日第56回北陸循環器核医学研究会



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Saitama International Medical Center

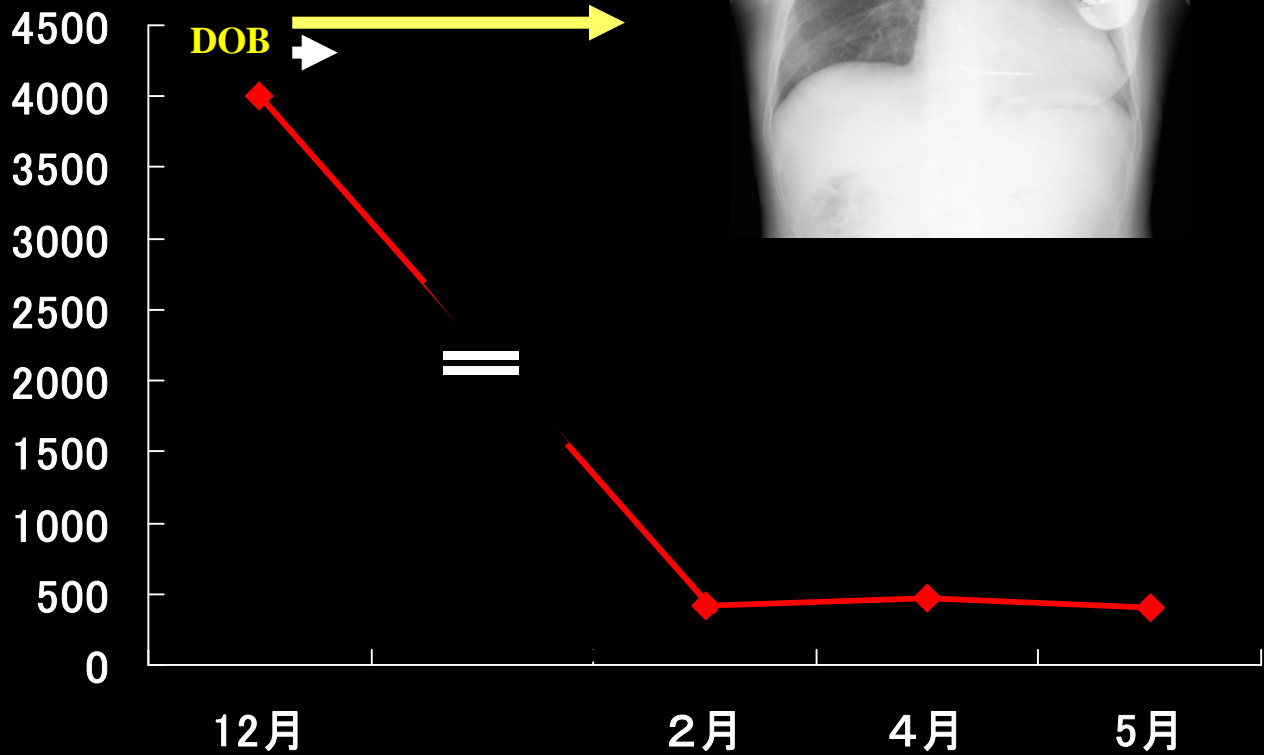


- 64歳女性 DCM
- VT stormとなりCRT-D
- 5ヶ月間のカテコラミン依存状態
- 退院後、すぐに再入院した例



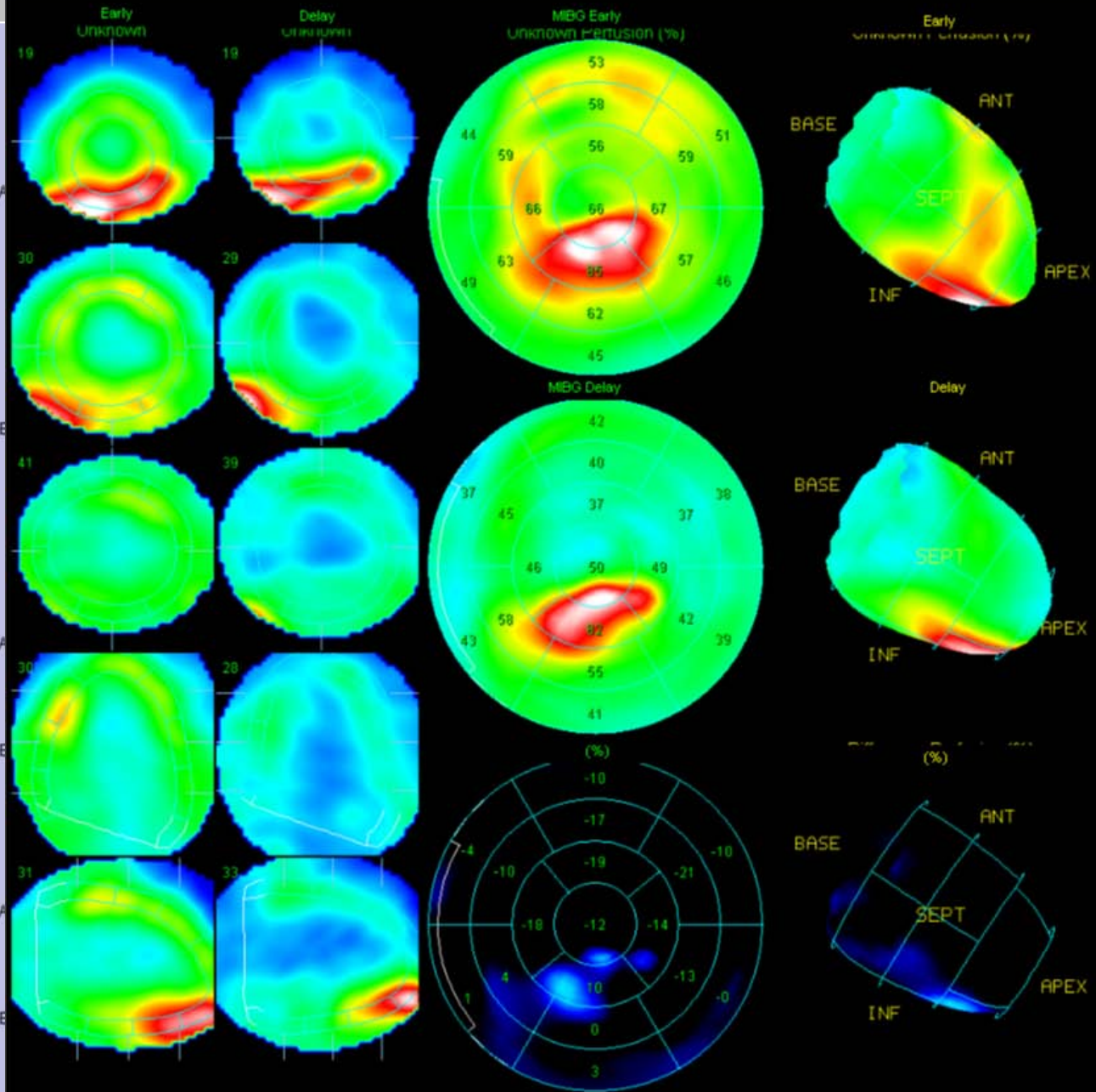
退院

和温療法



◆ BNP

SAVESCREENS: Save Screens QPS 7/7/2010



Name  
Pat ID  
Sex  
Limits  
S-S -- S-S -- SDS --  
S-% -- S-% -- SD% --

Study **Myocardial Perfusion**  
Dataset **MBG Early [Uncorrected]**  
Date **2010-07-07 10:46:02**  
Volume **516ml**  
Area **365cm<sup>2</sup>**  
Defect --  
Extent --  
Eccentricity **0.80**

Study **Myocardial Perfusion**  
Dataset **MBG Delay [Uncorrected]**  
Date **2010-07-07 13:38**  
Volume **535ml**  
Area **362cm<sup>2</sup>**  
Defect --  
Extent --  
Eccentricity **0.81**

	Unknown		Unknown		Diff
	Ext	Sev	Ext	Sev	
APX	--	--	--	--	--
LAT	--	--	--	--	--
INF	--	--	--	--	--
SEP	--	--	--	--	--
ANT	--	--	--	--	--
TOT	--	--	--	--	--

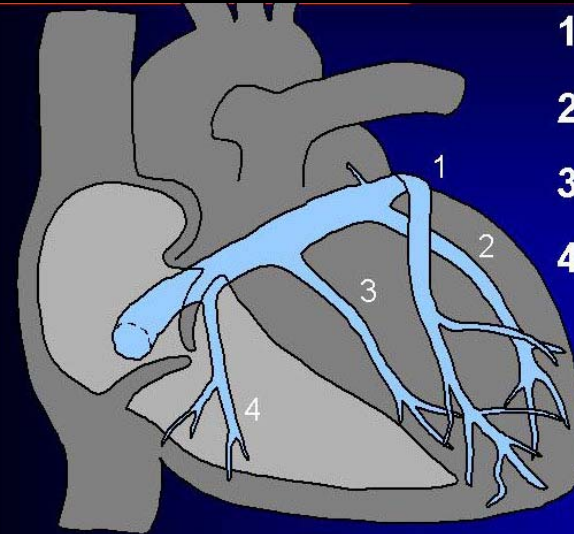
Left Anterior



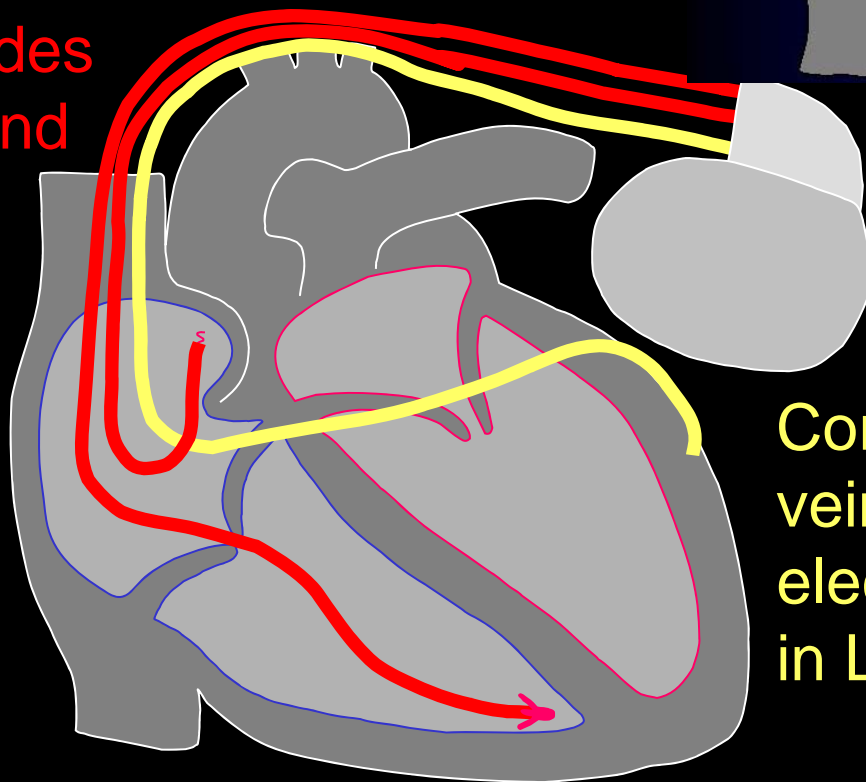
			和温療法 直後	和温療法後 7ヶ月	和温療法後 12ヶ月
		CRT前	CRT6ヵ月後	CRT後13ヶ月	CRT後2年
Echo	LVDd(mm)	72.9	66.6	70	76.7
	LVDs(mm)	62.4	65.9	65	70.5
	LVEF (%)	19	9	15	17
	EDV(Simpson)	226	233	175	167
	ESV(Simpson)	184.3	213.2	149	138
	MR	moderate	moderate	mild	mild
MIBG	H/M(early)		1.41	1.44	1.66
	H/M(delayed)		1.26	1.36	1.34
	WR (%)		54.4	42.4	60.5



# 心臟再同期療法 (CRT)



Electrodes  
in RA and  
RV



Coronary  
vein  
electrode  
in LV





# Responder vs Non-responder

- Asynchrony 評価
- Pacing site
- 心筋 viability
- 適応時期



# LV asynchrony の評価

■ 心電図: QRS幅 130msec以上

■ 心エコー図法

Tissue Doppler Imaging (speckle tracking法  
など)

■ 核医学

Cardio GRAF

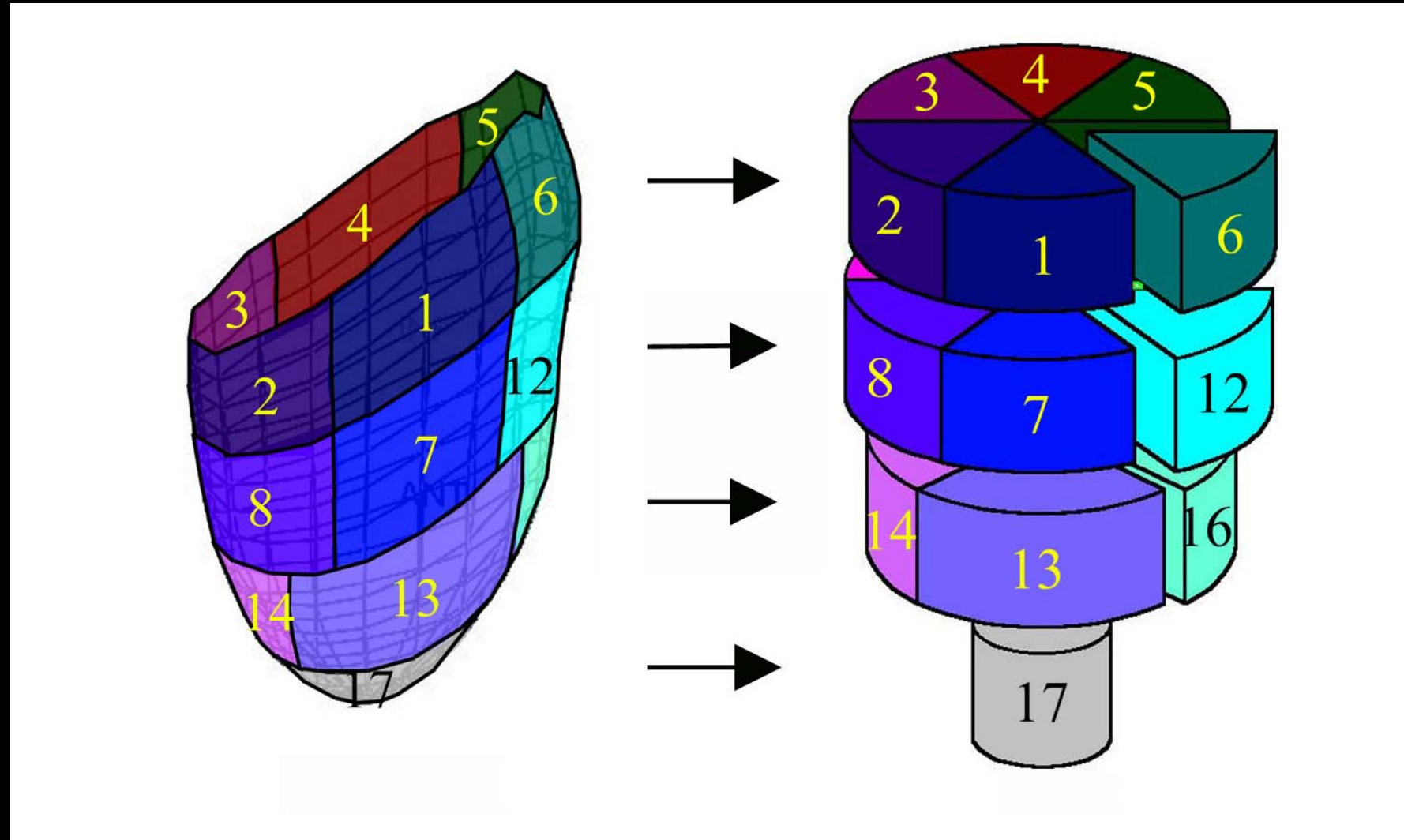
Pool-SPECT の高次位相解析

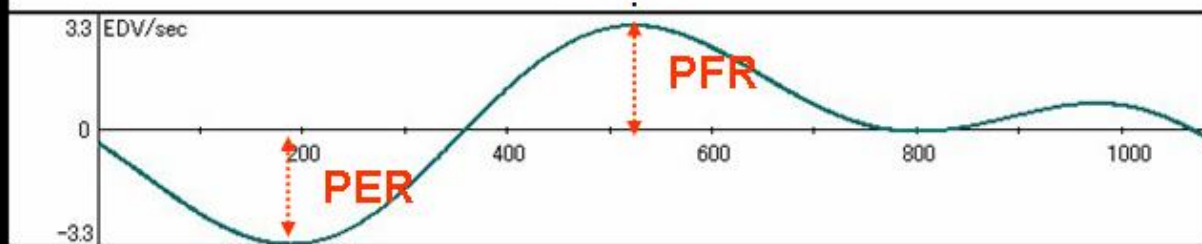
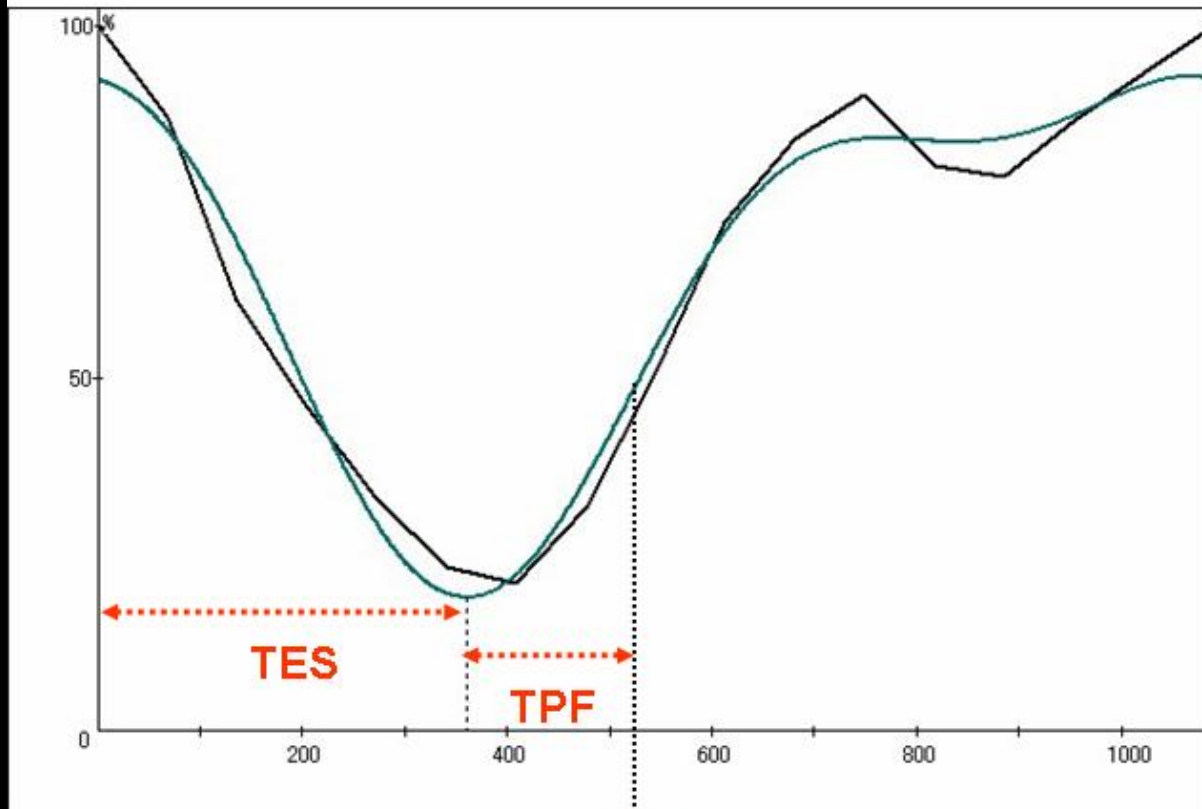


# Cardiac GRAF



# Cardio GRAF





Order  
2

Select Curve  
 EF  
 %WT  
 WM

Line On/Off  
 ES  
 TPE  
 TPF

Global  All

Select result  
 EF  %WT  WM

Original  
 Direct

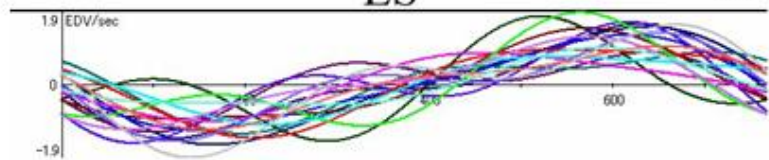
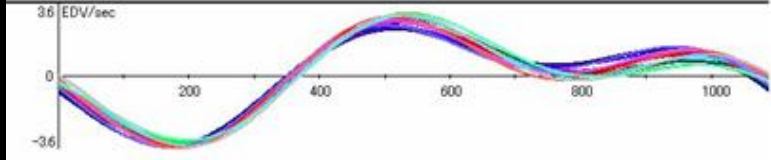
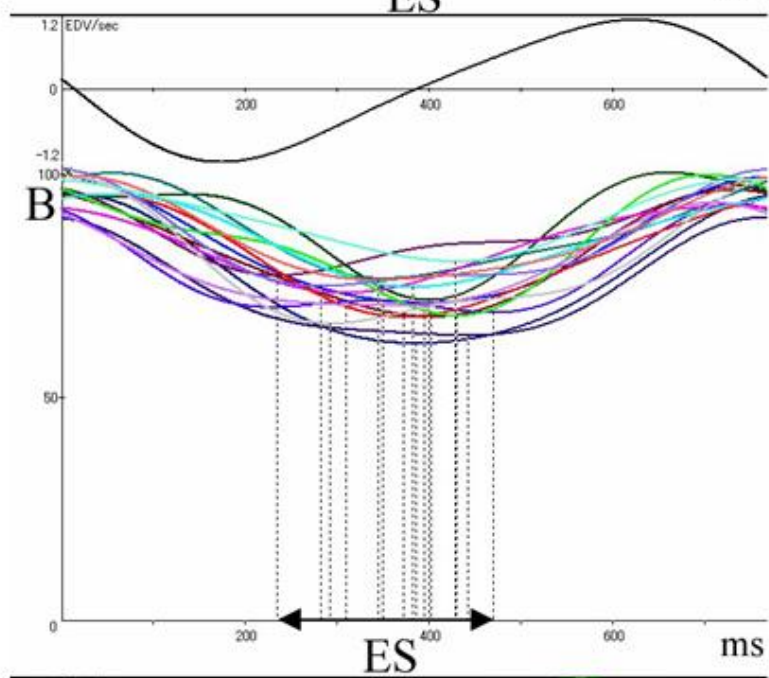
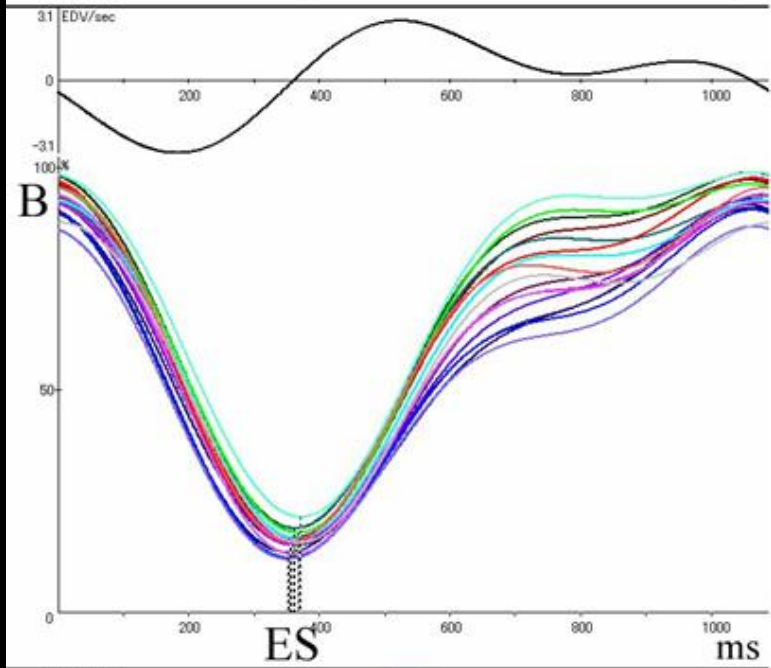
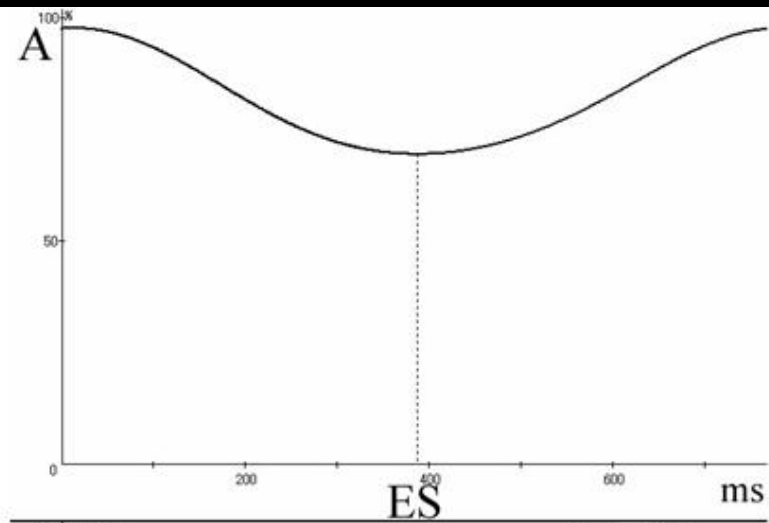
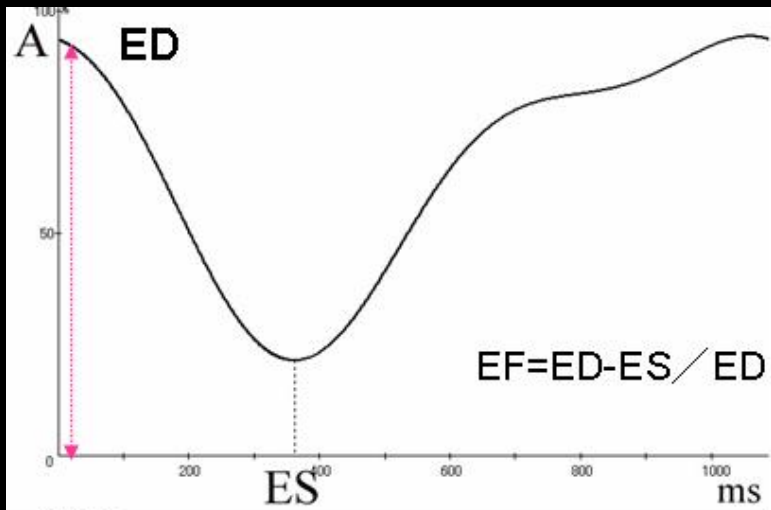
[Redraw]

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	Global

R-R Interval(msec) = 1090  
 Frame Duration(msec) = 68.18  
 HR(bpm) = 55

EDV(cc) =  
 ESV(cc) =  
 EF(%) = 77.59  
 TES(msec) = 360.3  
 CO(ml/min) =

TPE(msec) = 187.16	TPF(msec) = 162.14
1/3EF(%) = 19.87	1/3FF(%) = 67.44
1/3ER(EDV/sec) = 2.77	1/3FR(EDV/sec) = 2.26
PER(EDV/sec) = 3.32	PFR(EDV/sec) = 2.93
TDPF(msec) = 522.44	
EPFR(EDV/sec) = 2.93	TEPF(msec) = 522.44
LPFR(EDV/sec) = 0.7	TLPF(msec) = 973.81



# 心拍同期心プールSPECT の高次位相解析



# POOL-SPECT

- $^{99m}\text{Tc}$  pertechnetate (740mbq) was injected intravenously.
- POOL-SPECT imaging using a Prism 3000XP with a 3-headed single photon emission computed tomography with low-energy, high resolution, parallel-hole collimators.
- A total of 72 projection images obtained over 360 degree every 5 degrees of rotation were acquired in  $64 \times 64$  matrices on a magnetic disk with 16 frames/ cardiac cycle.
- The data acquisition time was 40 seconds for each projection.





## POOL-SPECT

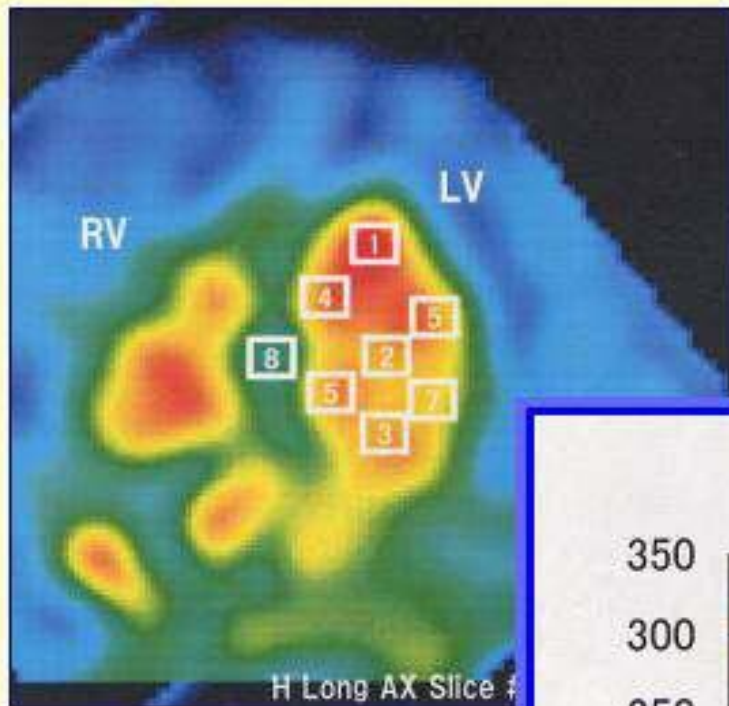
- Reconstructed images were made up of 3 cross-sectional images such as the serial short-axis view, the saggital vertical long-axis view and the horizontal long-axis view.
- Each images was evaluated visually in cine-mode, which is the same as for quantitative gated SPECT myocardial perfusion images.
- The phase images are automatically produced by Prism IRIX software.



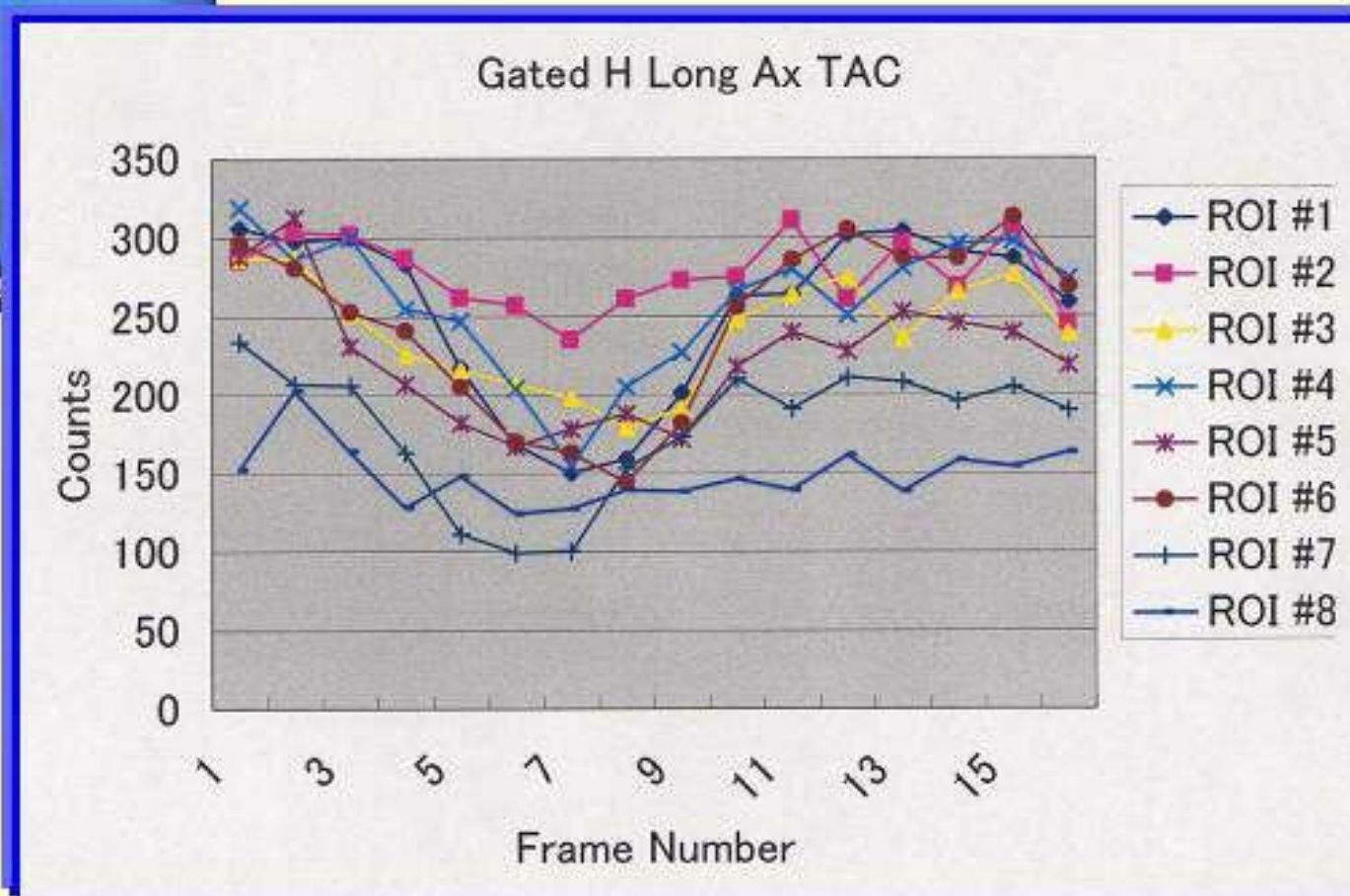
# Phase images

- The phase and amplitude of the fundamental wave of the discrete Fourier transform in each pixel's time-activity curve (TAC) were calculated and mapped as functional images.
- These phase distribution histograms described the number of pixels evaluating the end-systolic time angle for each ventricle and provided information about the contraction sequence quality.

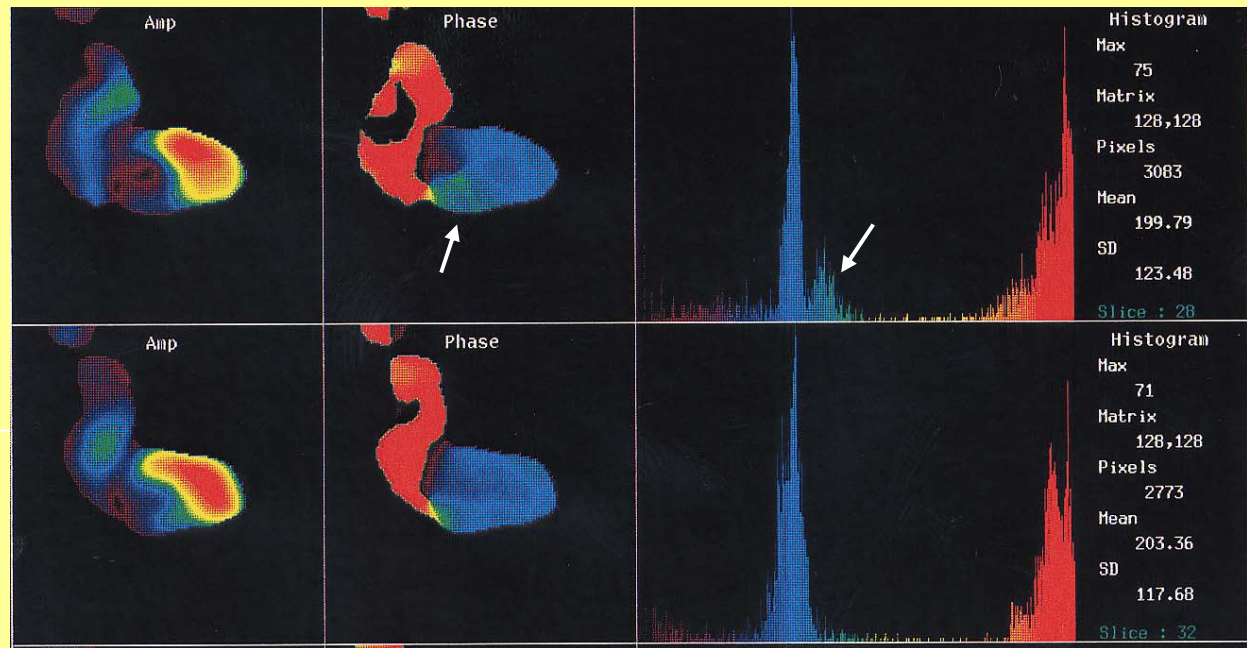
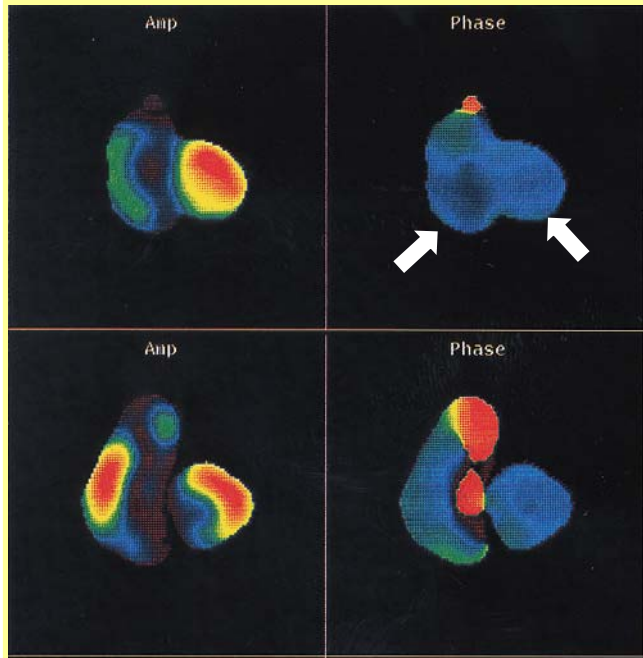




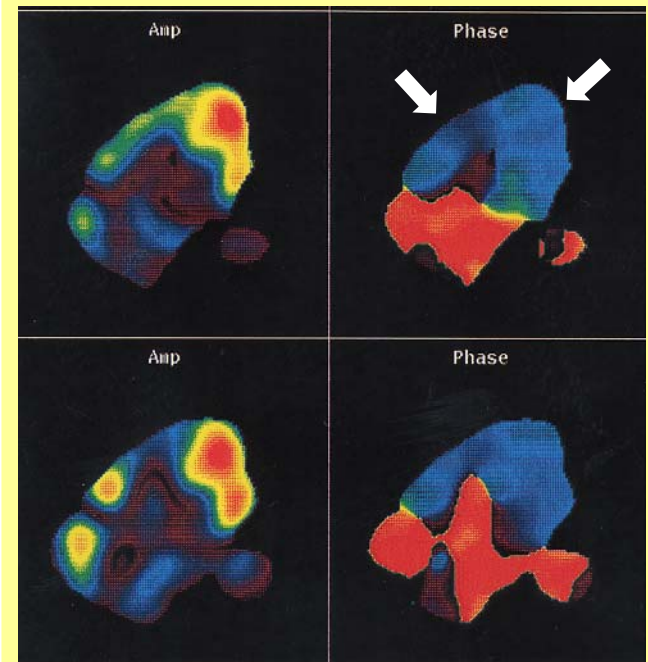
The link between the each of left ventricular segments and time activity curves in the normal control



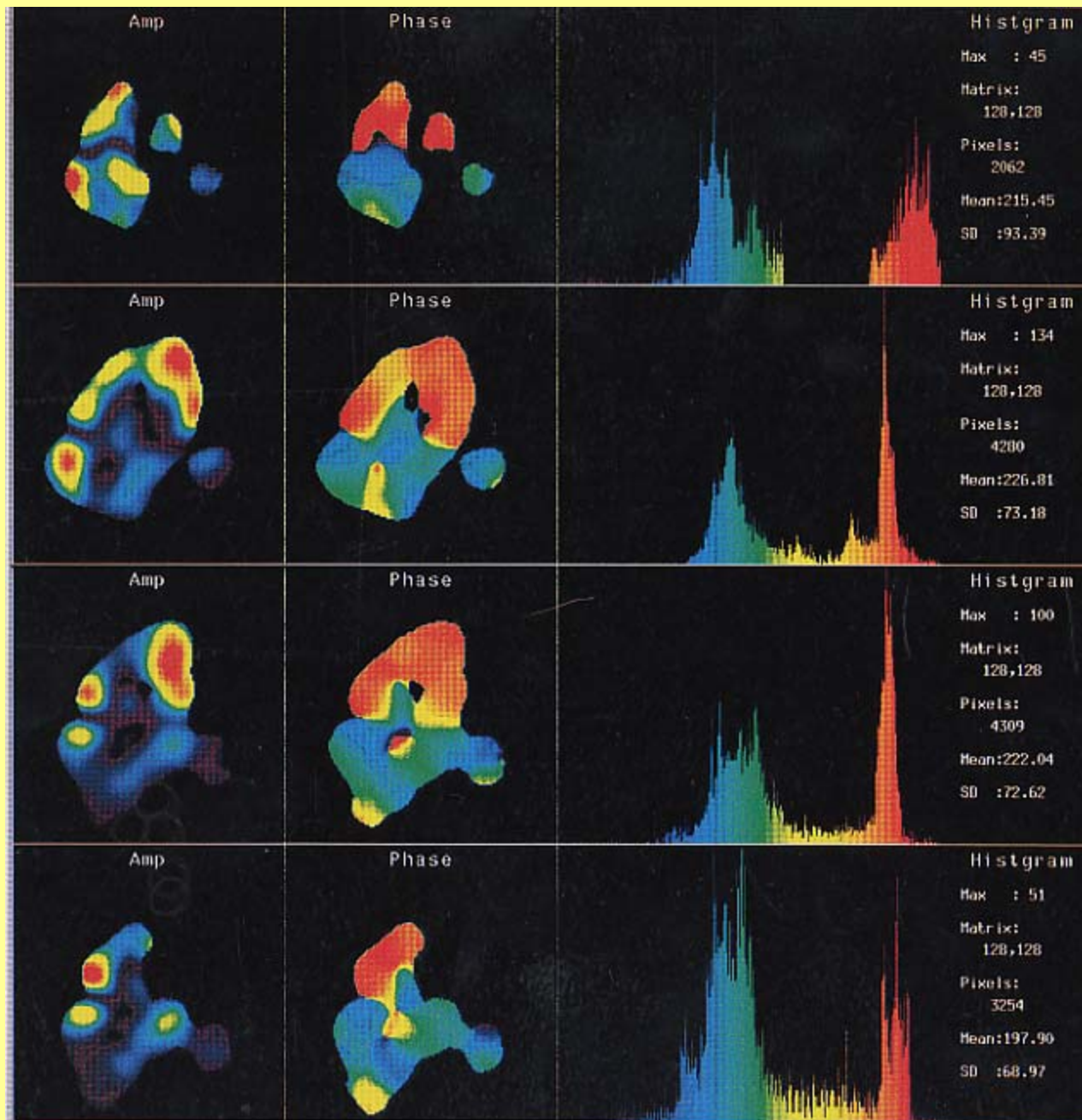
# Short axis view

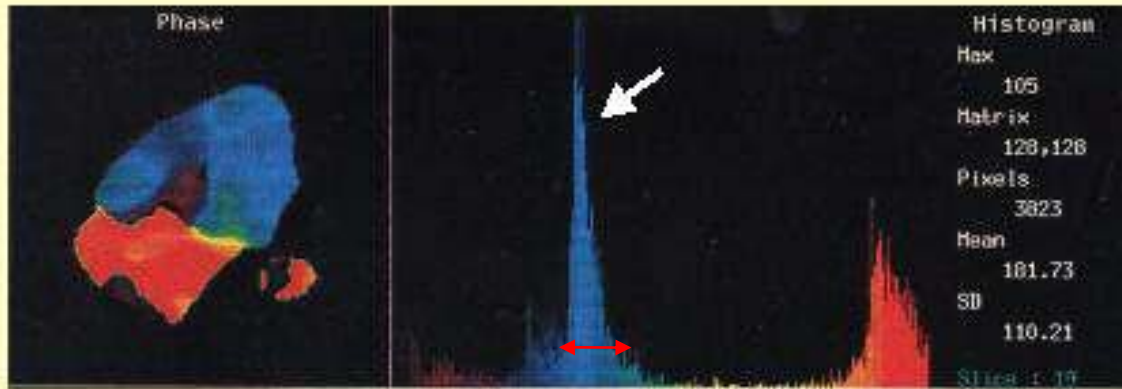
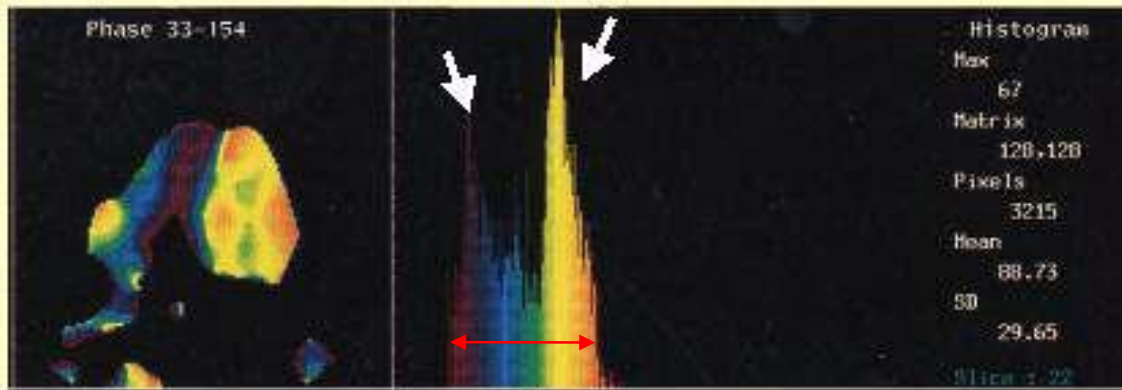
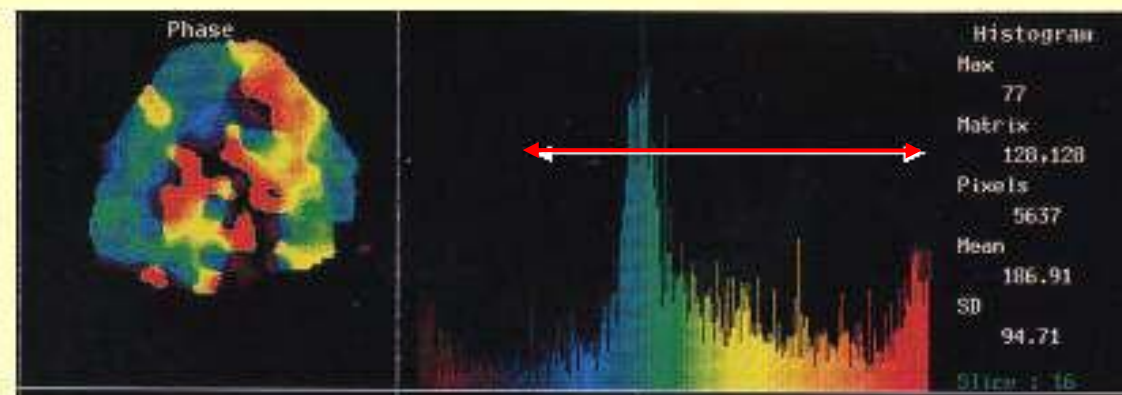


# Vertical long axis

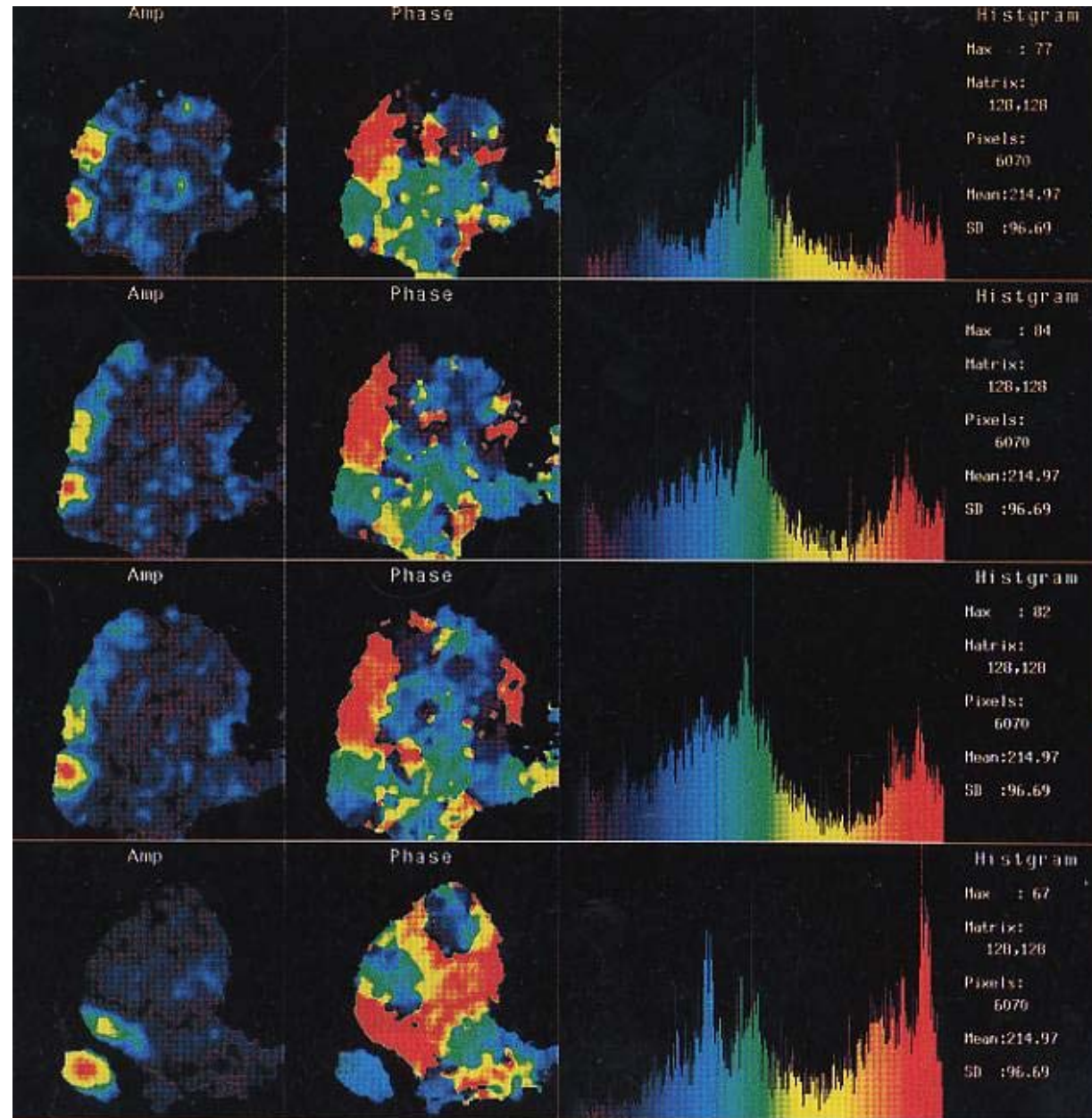


# Horizontal long-axis



**a****b****c****d**

# DCM 突然死例



# 方法-1

- 心拍同期心プールSPECTの高次元相解析でcardiac asynchronyを評価できるかを検討した
- 対象は、埼玉医科大学病院にてRI検査のfollowが可能であった拡張型心筋症(DCM)による心不全の連続19例





# The characteristics of all patients

2011年2月5日第56回北陸循環器核医学研究会

sex	age	rythm	QRSwidth (ms)	NYHA	LVEF	RVEF	EDV(ml)	Obsevation (months)
M	43	SR	106	I	47	35	111	24
M	36	SR	120	I	30	25	243	12
F	61	SR	111	III	17	25	199	30
M	40	SR	104	I	30	38	200	30
F	48	SR	131 (intraventri)	II	21	23	393	24
M	24	SR	118	III	12	16	459	8
M	35	SR	95	III	21	13	306	15
M	32	SR	106	III	10	21	236	35
F	66	SR	127 (intraventri)	II	30	24	196	12
M	54	SR	98	II	28	36	188	24
M	76	SR	75	II	27	40	222	12
M	47	SR	127 (intraventri)	III	16	48	324	24
M	76	SR	190 (LBBB)	III	11	31	532	8
M	70	VVI	160	III	21	15	317	14
F	65	SR	83	II	30	21	155	23
M	62	SR	213 (intraventri)	III	15	35	369	31
M	54	SR	187 (intraventri)	II	10	24	395	36
M	34	SR	120	III	23	34	330	8
M	26	SR	107	II	23	52	230	18

Division of Cardiology



Saitama International Medical Center

## 結果-1

\* : P&lt;0.01

Asynchrony (Phase imageから)	QRS width		LVEF(%)	NYHA	event
	Narrow	wide			
Interventricular(+) and Intraventricular(+)	5	5	16.6±6.0*	2.7±0.5*	CRT +death CRT+death CRT, LVAS
Interventricular(+) or Intraventricular(+)	2	2	22.8±5.4	2.5±0.6	CRT LVAS
Interventricular(-) and Intraventricular(-)	5	0	32.0±8.6*	1.4±0.5*	None



## 方法-2

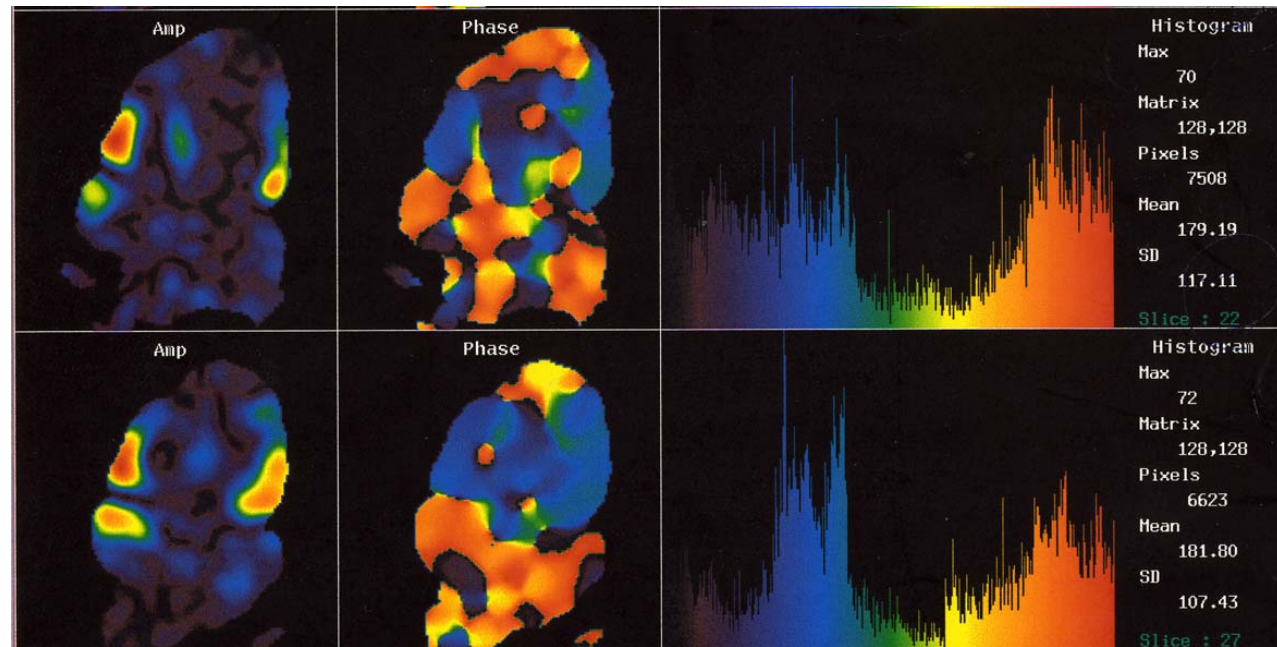
- 心拍同期心プールSPECTの高次位相解析はCRT設定に寄与するかを検討した
- 対象は、埼玉医科大学病院にてCRT施行し、かつ、RI検査followが可能であった心不全7例



# 対象

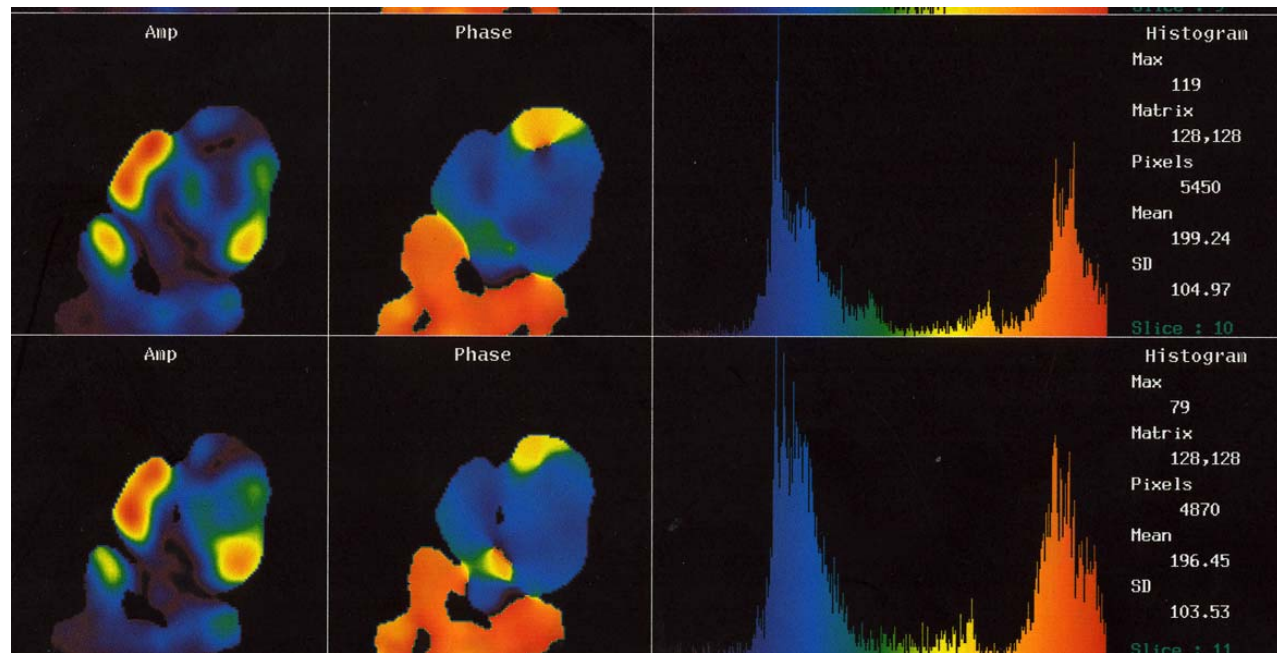
- CRT施行した 7例(2002.10月～2004.10月)
  - 1) 男性 5名; 女性 2名
  - 2) 年齢  $63 \pm 16$ 才
  - 3) LVEF  $22.1 \pm 3.7\%$
  - 4) NYHA II M- 1名, III- 6名
  - 5) DCM 6名, ICM 1名
  - 6) 全例: 利尿薬・ $\beta$ ブロッカー・ACE-I投与





# CRT前

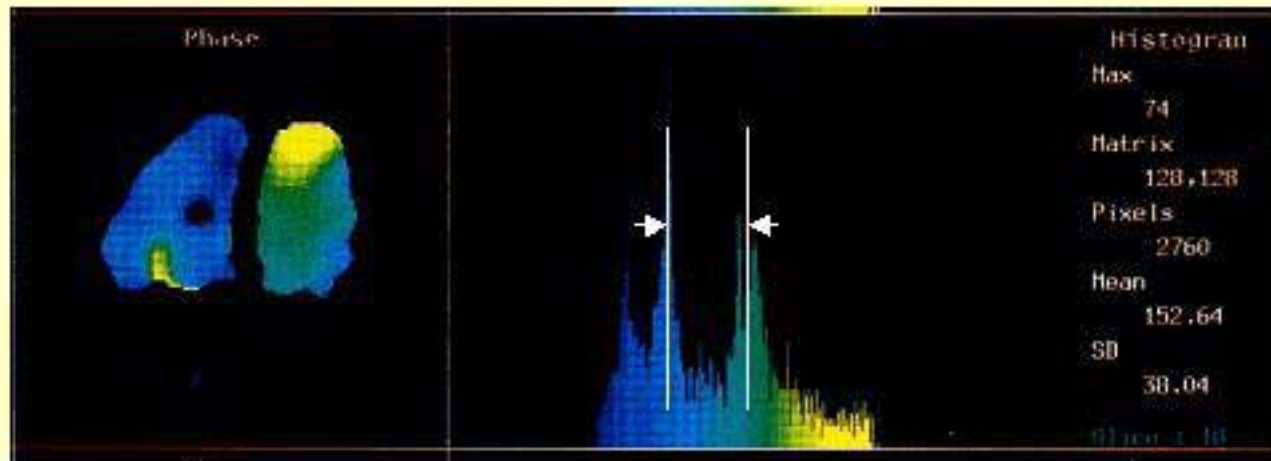
EDV 344ml  
ESV 262ml  
EF 24%



# CRT後

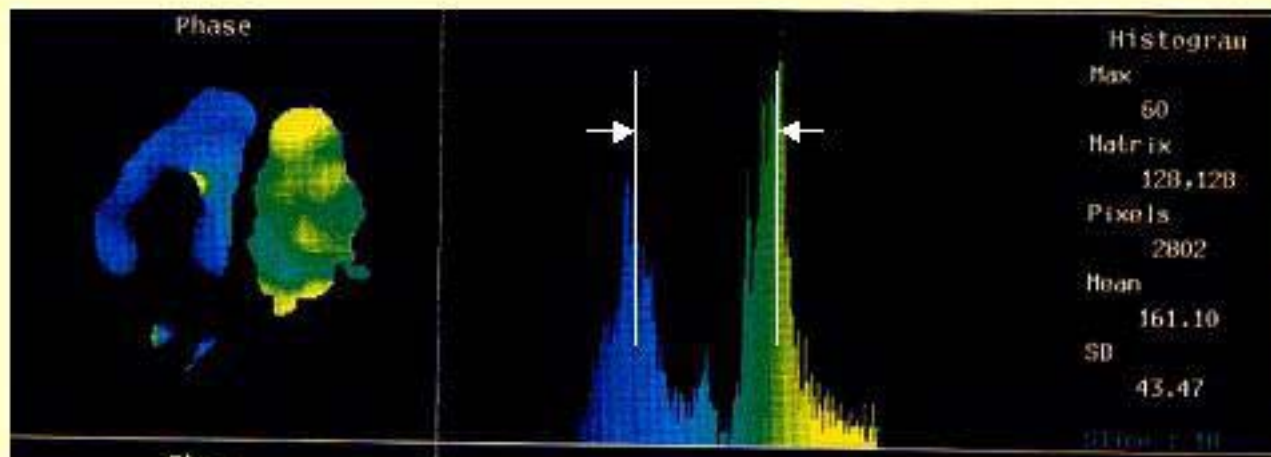
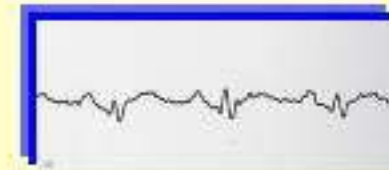
EDV 309ml  
ESV 198ml  
EF 36%

# Case presentation



**Pacing-on**

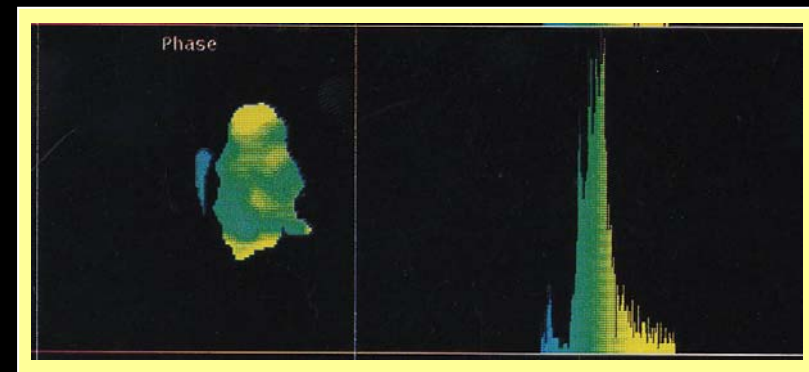
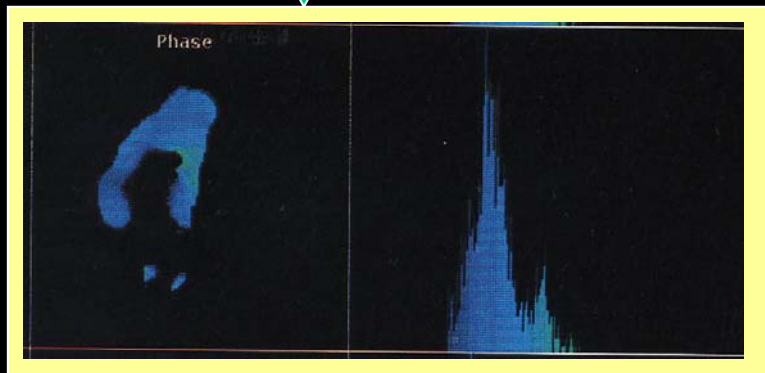
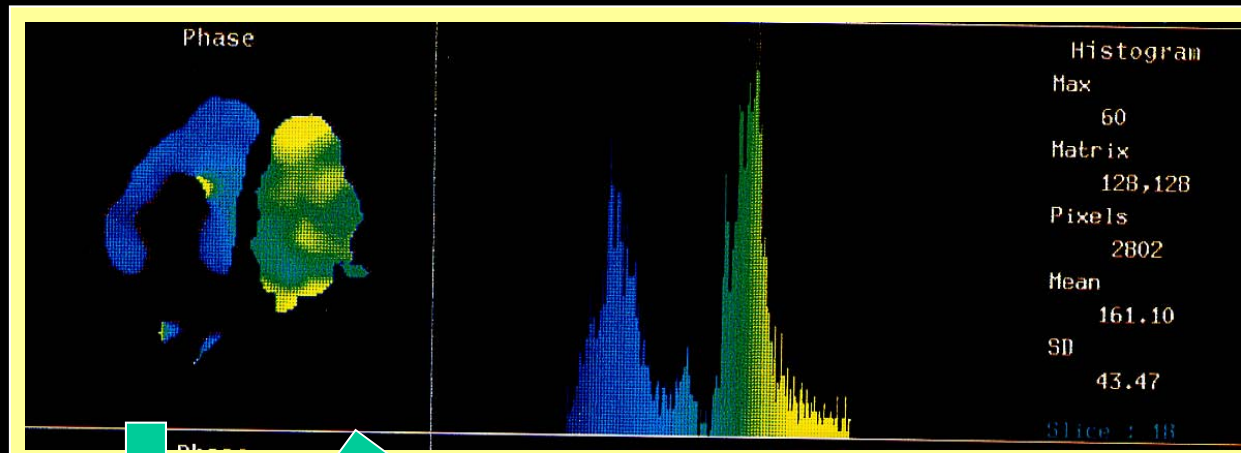
**(LVEF29%)**



**Pacing-off**

**(LVEF22%)**



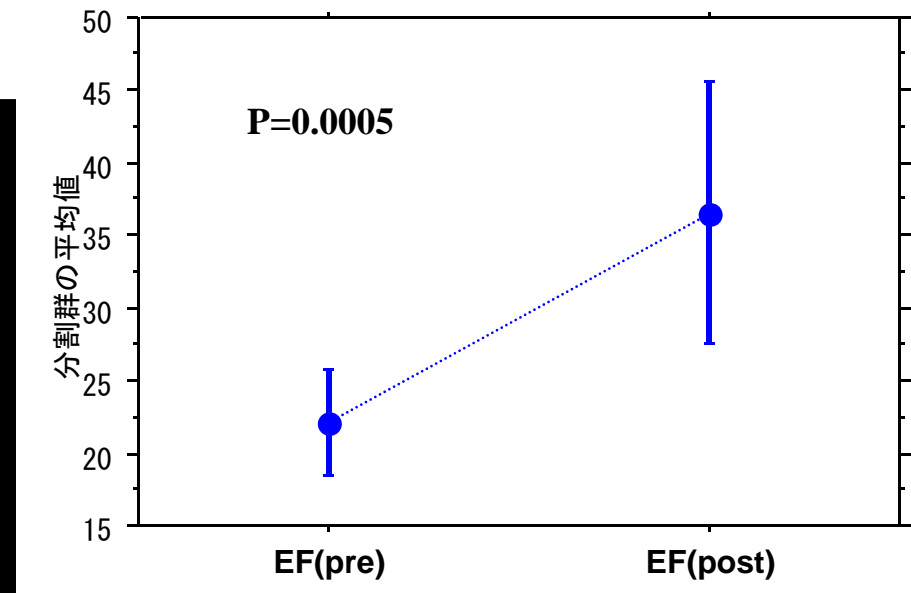
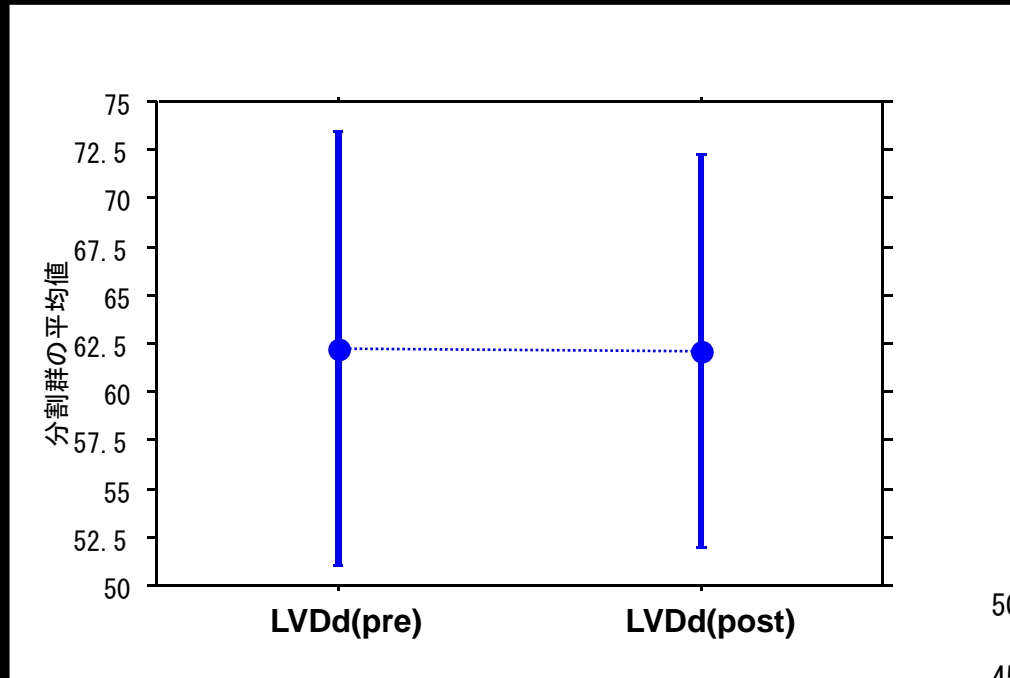


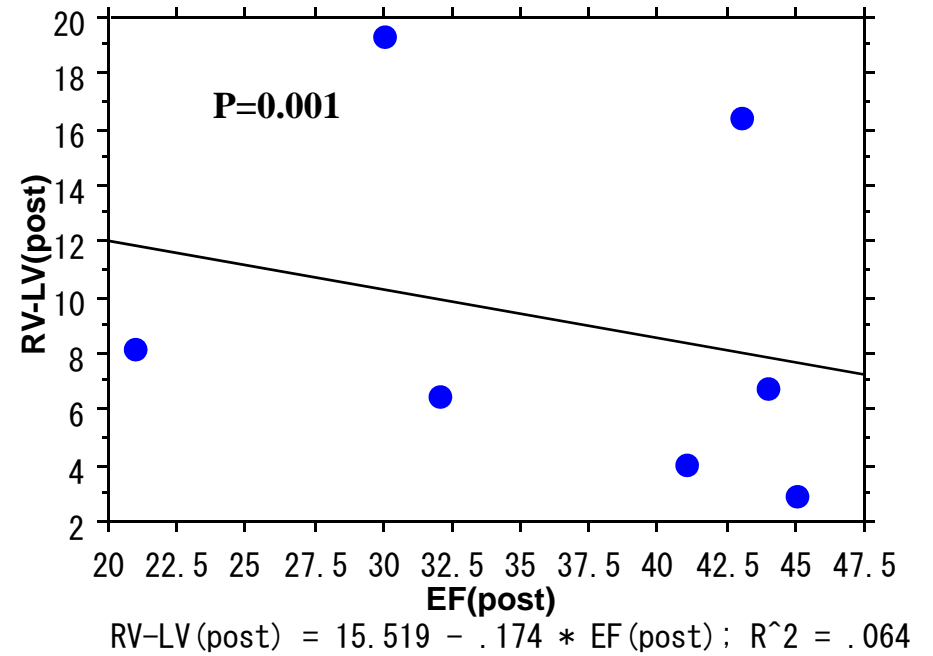
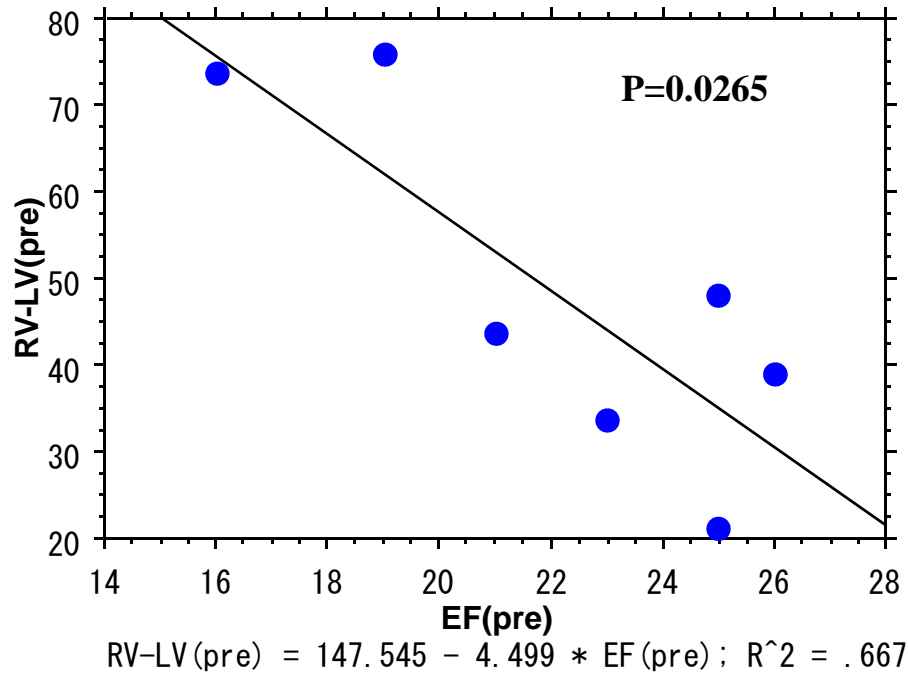
## 結果-2

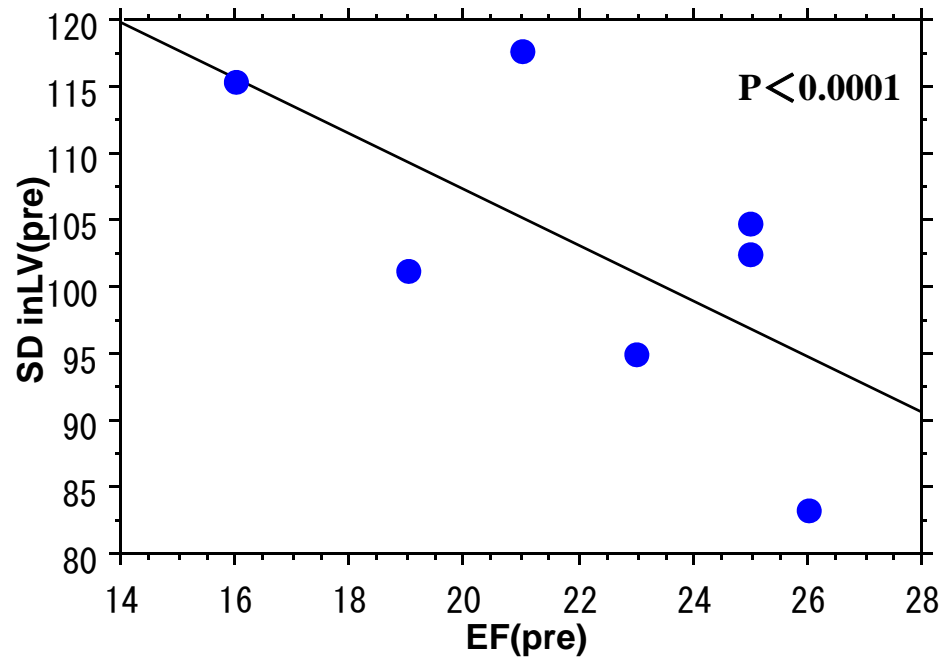
disease	age	QRS	EF(pre)	EF(post)	RV-LV (pre)	RV-LV (post)	SD of mean phase in RV (pre)	SD of mean phase in LV (pre)	SD of mean phase in RV(post)	SD of mean phase in LV(post)
ICM	61	VVI	23	41	33.6	4.1	108.7	94.9	97.4	70.1
DCM	76	LBBB	16	21	73.7	8.2	101	115.5	102	79.2
DCM	31	intraver	19	30	75.9	19.3	110	101.2	64.9	67.3
DCM	76	LBBB	25	44	48	6.8	118	104.7	114.8	51.2
DCM	70	VVI	21	32	43.8	6.5	86.5	117.8	106	73.2
DCM	57	VVI	26	43	39	16.4	96.2	83.4	95.2	48.9
DCM	74	LBBB	25	45	21.4	2.9	113	102.4	96	80.5



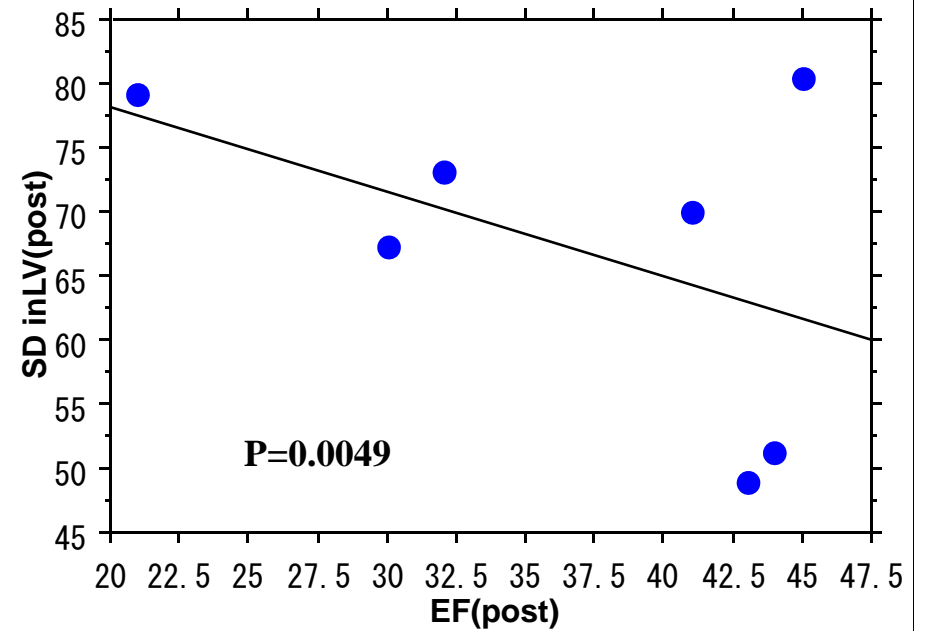






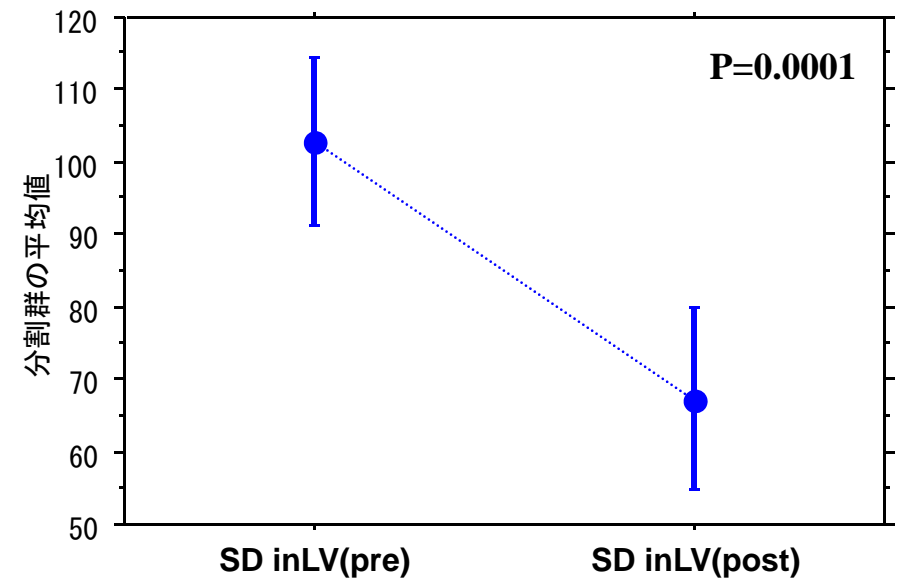
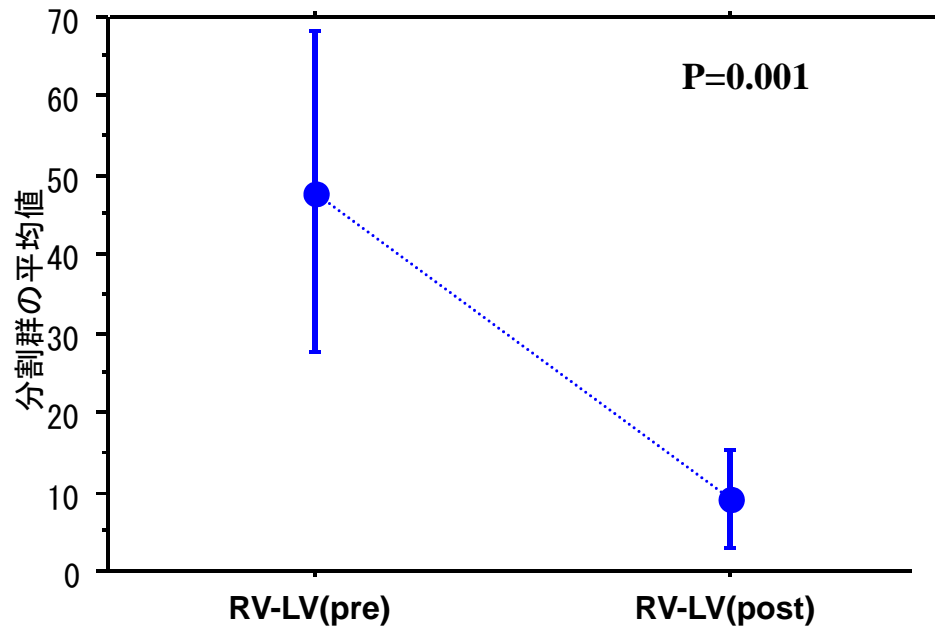


$SD\ inLV(pre) = 148.697 - 2.071 * EF(pre); R^2 = .417$



$SD\ inLV(post) = 91.385 - .661 * EF(post); R^2 = .2$





## 方法-3

- 埼玉医科大学病院にてCRT施行し、  
RI検査followが可能であったCRT植え込み11症例
- Responder ; 植え込み後EF10%以上改善、もしくは  
心臓死や心不全入院など心イベントを生  
じなかったもの
- Non-responder; 上記にあてはまらないもの



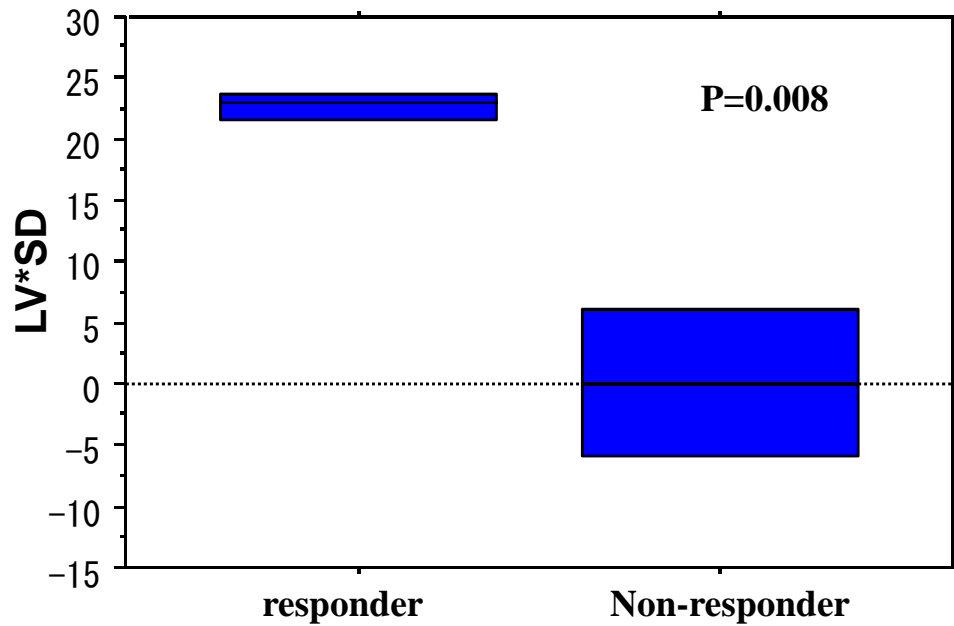
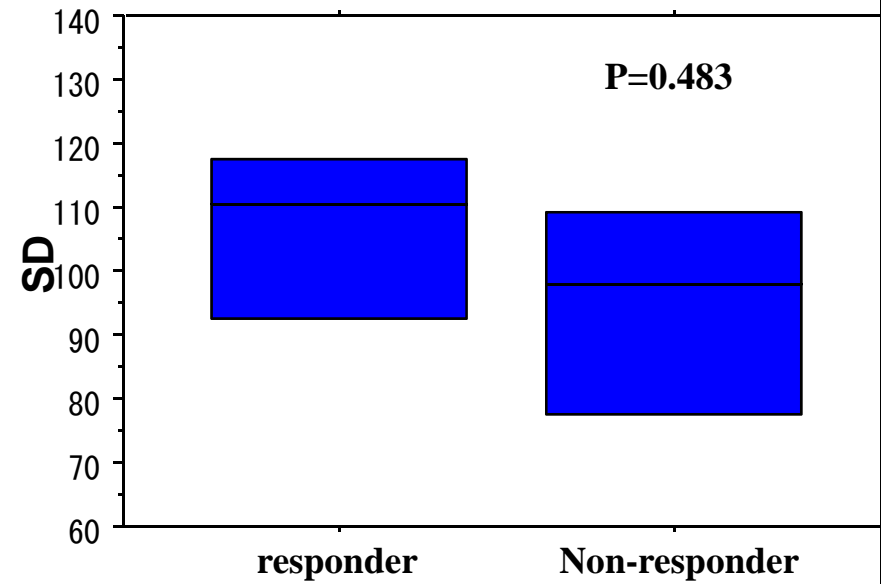
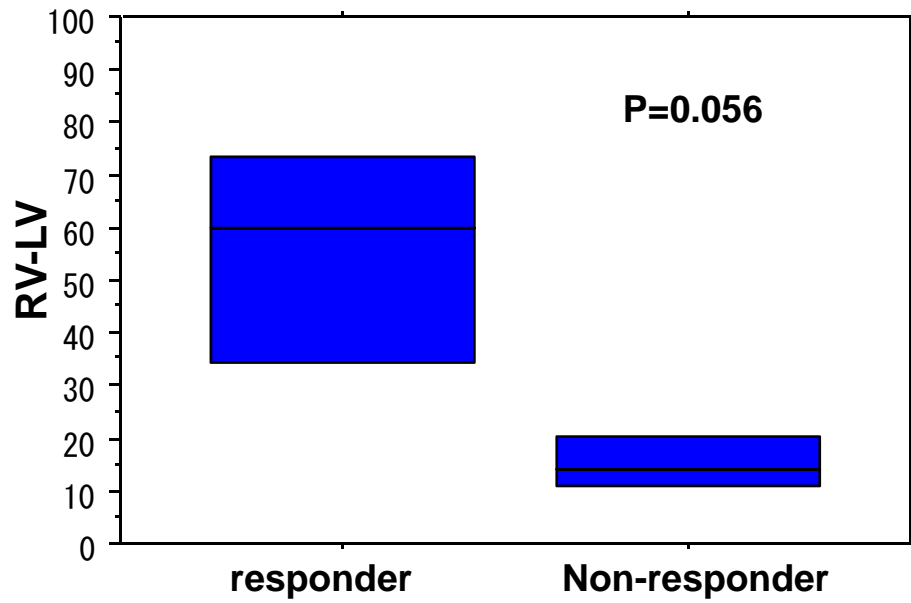
## The characteristics of patients who were consecutive 11 patients underwent CRT due to CHF (DCM6,ICM4,C-AVB1)

Disease	age	QRS com	pre- EF	post- EF	RV-LV	SD	$\Delta$ LV*SD	event
ICM	67	IRBBB	28	23	14	98.1	-8	CHF
ICM	61	VVI	23	41	28.2	115.3	24	free
ICM	72	narrow	27	31	10	70.4	1	free
ICM	74	LBBB	25	45	50	120	23	free
C-AVB	55	LBBB	26	37	-	-	-	free
DCM	76	DDD	16	19	17.4	129.5	2.9	death(c)
DCM	60	narrow	44	51	10.6	96.4	18	free
DCM	31	wide	19	29	45.1	105.3	21	HTX regist
DCM	28	wide	30	16	22.3	113	8	HTX regist
DCM	76	wide	25	44	28.3	124	35	free
DCM	70	VVI	21	32	19	79.8	26	Death (non-c)

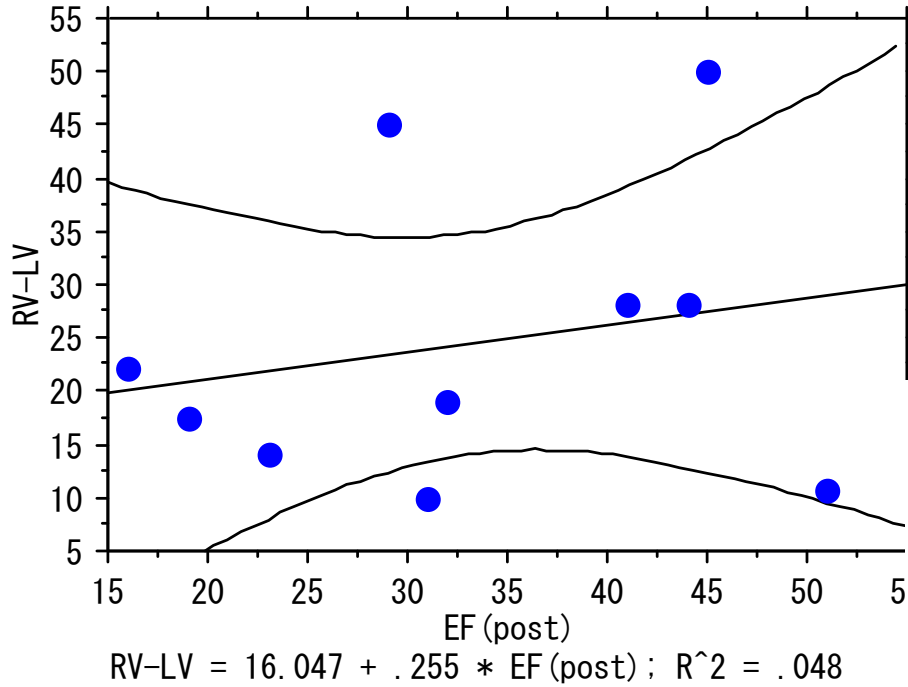
$\Delta$ LV\*SD(%)= pre SD in LV – post SD in LV / pre SD in LV

— Responder





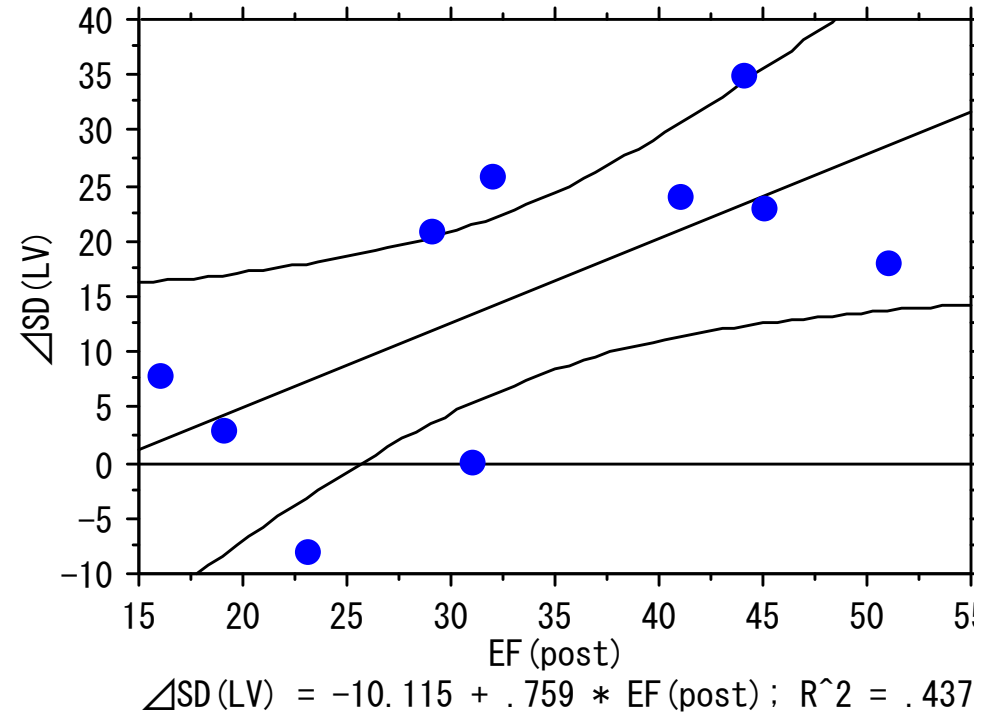
散布図 と回帰直線  
95% 信頼区間



t検定 (対応あり)  
仮説平均値の差= 0

	平均差	自由度	t値	p値
EF (post), $\Delta$ SD (LV)	18.100	9	5.414	.0004

散布図 と回帰直線  
95% 信頼区間



t検定 (対応あり)  
仮説平均値の差= 0

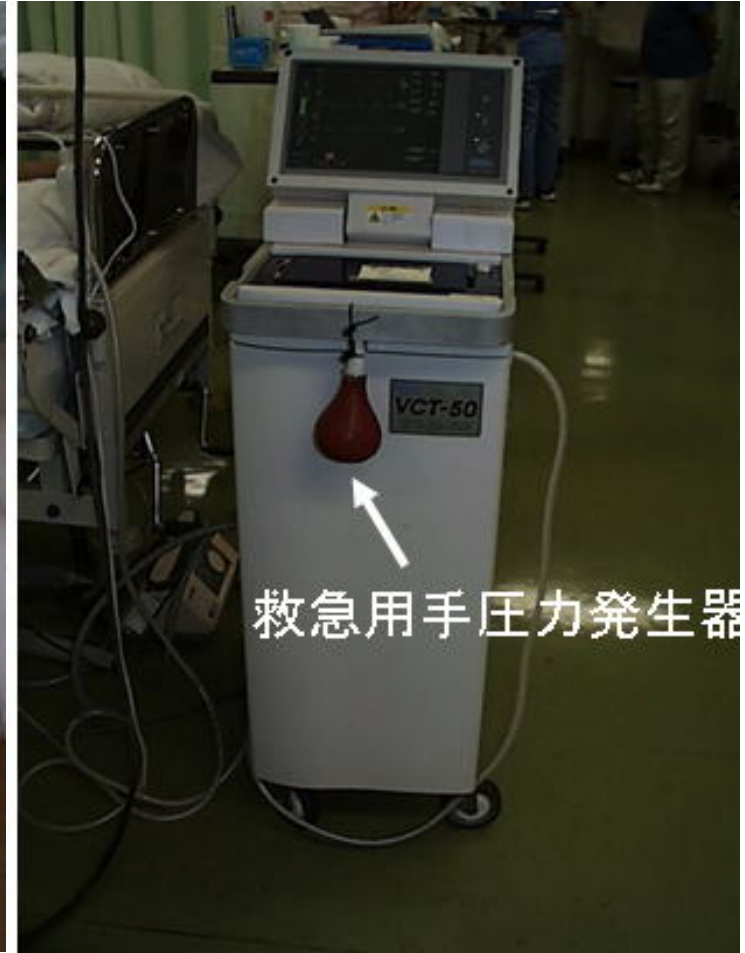
	平均差	自由度	t値	p値
EF (post), RV-LV	8.610	9	1.696	.1241





# LVAS





東洋紡式



Division of Cardiology

Saitama International Medical Center

## DuraHEART

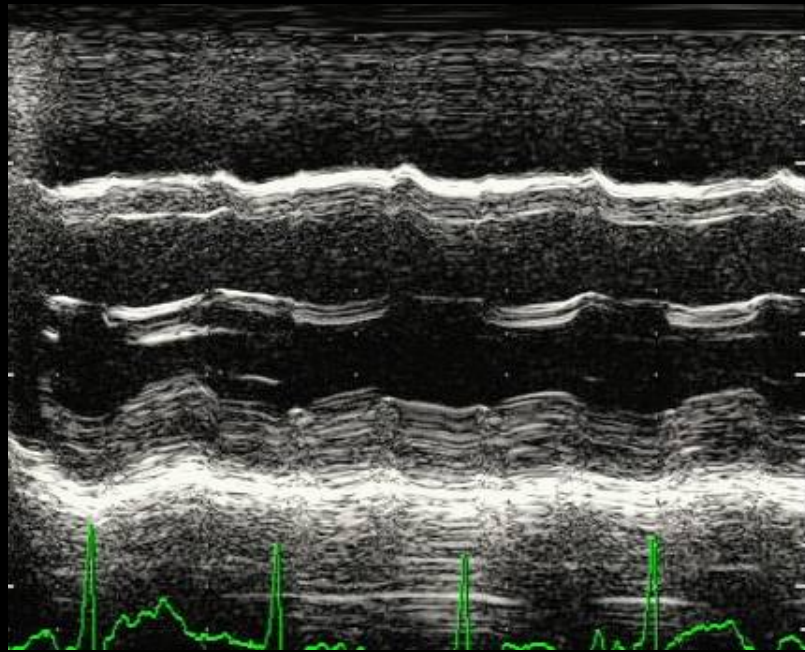


## EVAHEART



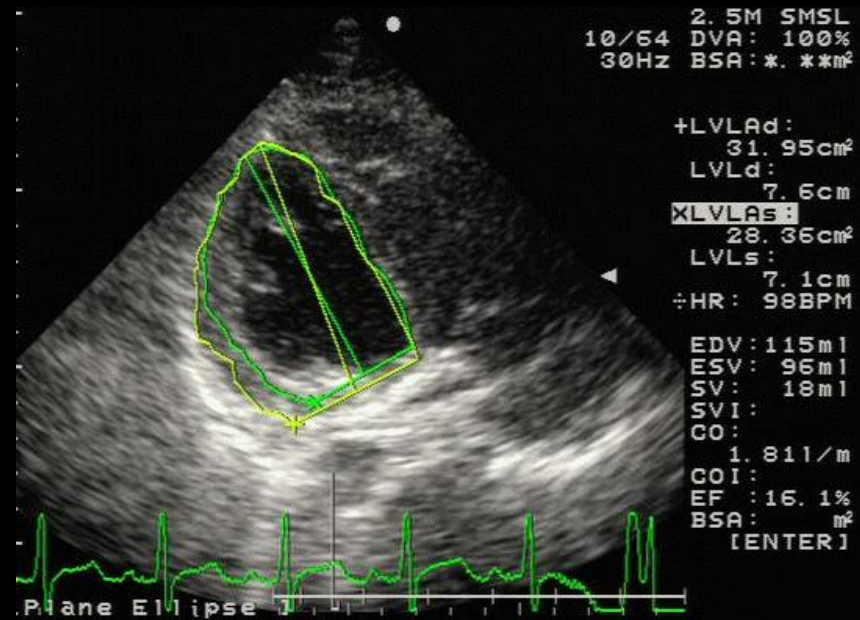
# 症例1 (離脱例); 26歳DCM、男性

## LVAS装着1ヵ月後の心エコー図



LVDd/Ds 76/69mm

装着前 LVEF 21%



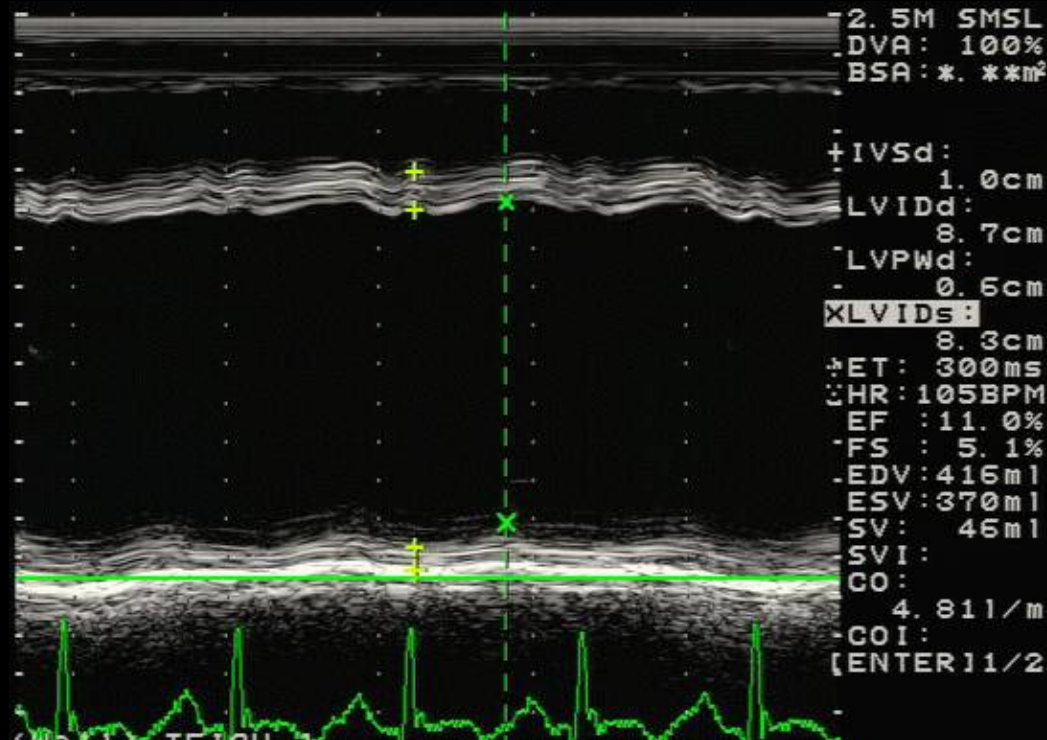
LVDd/Ds 54/50mm

1ヵ月後 LVEF 11%



# 症例2(非離脱例); 33歳DCM、男性

## LVAS装着1ヵ月後の心エコー図



LVDd/Ds 88/82mm

LVDd/Ds 86/81mm

装着前 LVEF14%

1ヵ月後 LVEF 13%

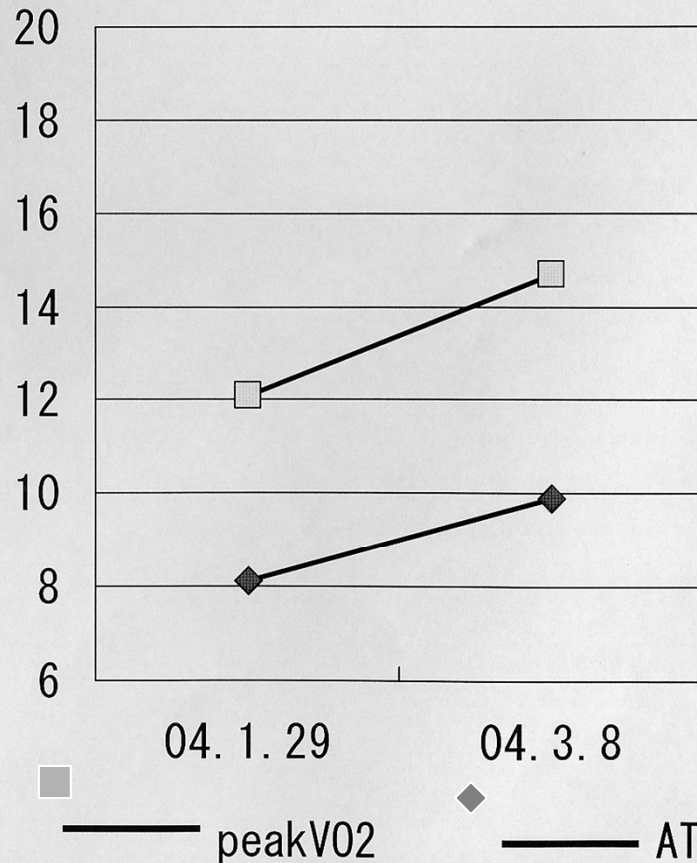


# リハビリ開始 (LVAS装着1カ月後)後の経過

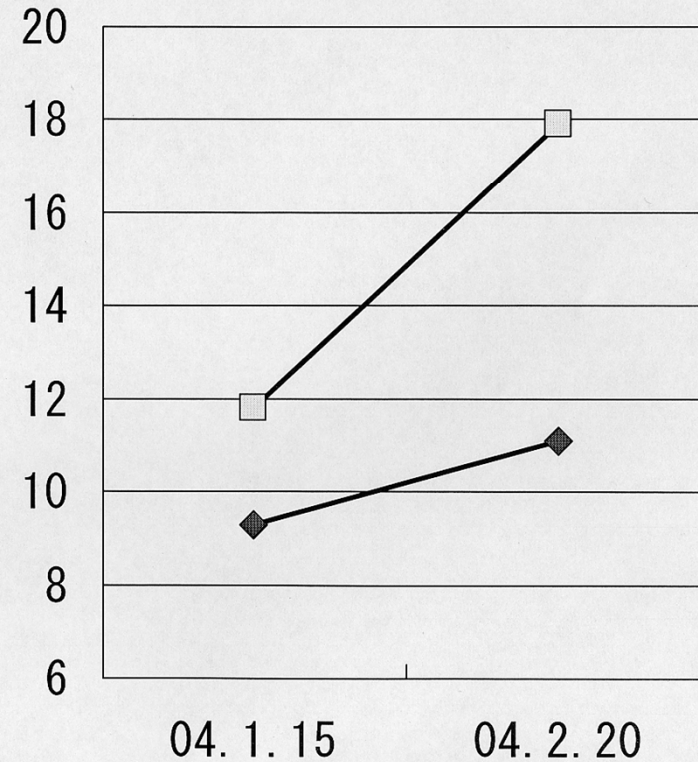
## 症例2

## 症例1

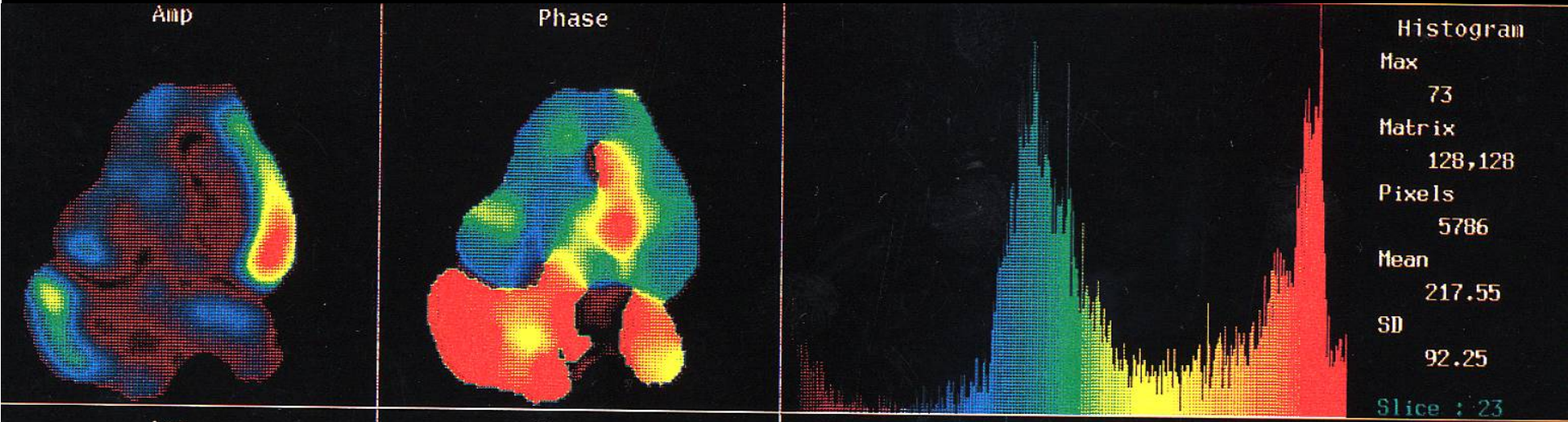
F. S. 33才 男性 DCM  
03/12/20 LVAS (TOYOB0) (mL/min/kg)



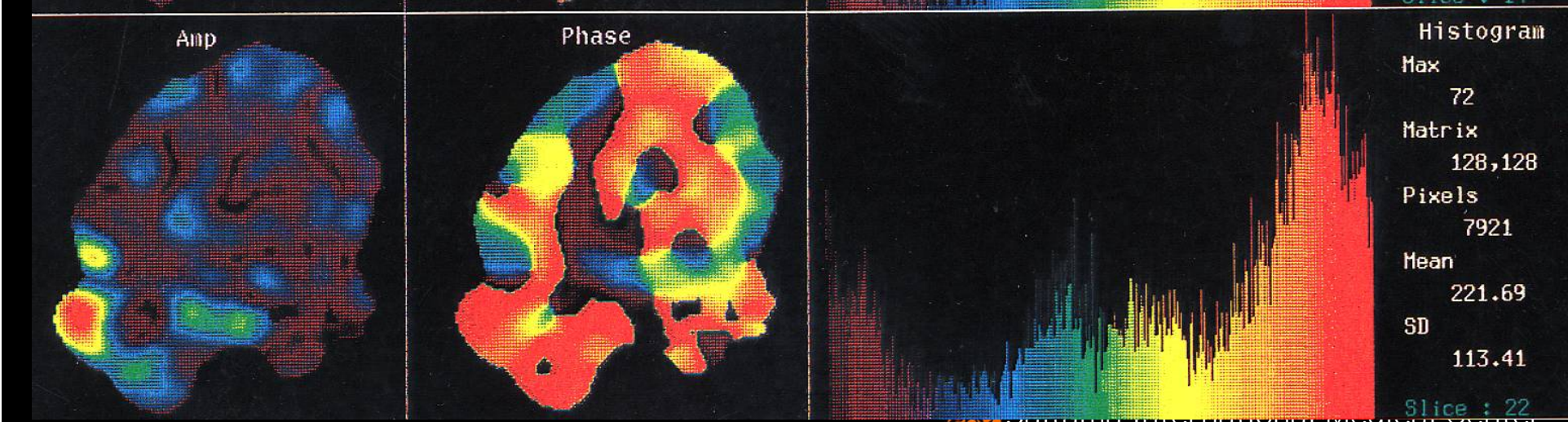
S. Y. 26才 男性 DCM  
03/12/12 LVAS (TOYOB0)



# 症例1 LVAS装着2ヵ月後



# 症例2 LVAS装着3ヵ月後



循環器病の診断と治療に関するガイドライン (2009年度合同研究班報告)

## 心臓核医学検査ガイドライン (2010年改訂版)

Guidelines for Clinical Use of Cardiac Nuclear Medicine (JCS 2010)

### ③ 局所壁運動, アシンクロニーの解析

心プールシンチグラフィにおいては心室全体の収縮能のみならず, 局所の壁運動と機能を求めることができる。局所壁運動の評価はLAOからの撮像しかできない平衡時マルチゲート法は, RAOが撮像できる初回循環法に比べ特に下壁の壁運動低下を捉えるのが不得手であるとされる<sup>66)</sup>。最近では心プールSPECTにより壁運動を3次元で自由に観察できるようになった。位相解析法は各マトリックスのTACをフーリエ変換し, その位相角を位相イメージとして表示するもので, アシンクロニー (収縮の不同時性) をイメージとして表現することができる<sup>67)</sup>。近年, 両心室ペーシングによる心不全治療法やWPW症候群のKent東部位同定, 心室瘤切除において位相評価が施行されてきた<sup>671)-677)</sup>。

