

특발성 확장성 심근병증 환자에서 수축기말 압력-용적 관계선을 이용한 좌심실의 수축예비능의 평가 : 병리조직학적 검사와 비교 연구

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정남식¹ · 장양수¹ · 하종원¹ · 변영섭¹ · 이남호¹ · 임세중¹ · 이문형¹
심원흠¹ · 조승연¹ · 김성순¹ · 조상호² · 윤영로³ · 석주현³ · 신재우³

Analysis of the Left Ventricular Contractile Reserve Using End-systolic Pressure-Volume Relation (ESPVR) in Idiopathic Dilated Cardiomyopathy : Its Correlation with Pathologic Findings

Namsik Chung, MD¹, Yangsoo Jang, MD¹, Jong-Won Ha, MD¹,
Young-Seop Byeon, MD¹, Nam-Ho Lee, MD¹, Se-Joong Rim, MD¹,
Moon-Hyung Lee, MD¹, Won-Heum Shim, MD¹, Seung-Yun Cho, MD¹,
Sung-Soon Kim, MD¹, Sang-Ho Cho, MD², Young-Ro Yoon, PhD³,
Joo-Hyun Seok³ and Jae-Woo Shin³

¹Cardiology Division, Department of ²Pathology, Yonsei University College of Medicine, Seoul,

³Department of Biomedical Engineering, Yonsei University College of Health Science, Wonju, Korea

ABSTRACT

Background : Left ventricular (LV) end-systolic pressure volume relation (ESPVR) is considered as a load independent contractile index. However, its application in human beings has been limited by the difficulty in the accurate real time measurement of the LV volume changes. With introduction of the echocardiographic automatated edge detection method, on-line generation of multiple LV pressure volume-loops has become possible to assess ESPVR. This study was performed to investigate the correlation of the degree of myocardial damages with myocardial contractility and contractile reserve assessed by ESPVR as a surrogate of contractility index. **Methods :** Studies were attempted in ten patients with idiopathic dilated cardiomyopathy. Baseline two-dimensional and Doppler echocardiography, cardiac catheterization for hemodynamic assessment and endomyocardial biopsy were performed. Generation of multiple LV pressure-volume loops during occlusion and release of the inferior vena cava by a balloon catheter was performed using the volume signals from the echocardiographic automatated edge detection method and the pressure signals from a 5F fluid-filled lumen catheter. ESPVR was measured at the baseline and after 3 minutes of dobutamin infusion (10 µg/Kg/min). **Results :** No correlation was observed between the degree of myocyte hypertrophy change or interstitial fibrosis and the two-dimensional echocardiographic or hemodynamic data. However, restrictive LV filling pattern was more common in the patients with severe degree of myocyte hypertrophy change. Myocardial

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: (02)363 - 7071 · : (02)393 - 2041

E - mail : namsikc@yumc.yonsei.ac.kr

contractility and contractile reserve were also significantly reduced in this patient group. The degree of interstitial fibrosis did not affect myocardial contractility or contractile reserve in this particular patient group. **Conclusion** : Assessment of ESPVR using the echocardiographic automatated edge detection method was feasible in the patients with idiopathic dilated cardiomyopathy. The degree of myocardial hypertrophy change was prominent in the patients with reduced contractility and contractile reserve. (**Korean Circulation J 1999; 29(7):751-761**)

KEY WORDS : LV function · ESPVR · Pressure-volume loop · Dilated cardiomyopathy.

서론 (end-systolic pressure-volume relation, ESPVR) 가 dobutamin 가 actin myosin (NYHA) Class), S3, 1-11), 1-3)10)12-14), 5)15), Na¹⁶⁾¹⁷⁾, norepinephrine, atrial natriuretic peptide, renin 대 상 가 35% 25%, 19) 가 10)13)20)21) 가 14 10 (54.6±9.4, 7) , NYHA class 4, class 4, class 2 24.6±7.5 % 방 법 Doppler

Quinone ²²⁾ Cordis biotome
RAO 30 LAO 45
PW
Doppler
E wave velocity, E wave deceleration time, E/A
ratio, A wave
PW Doppler (0), (+1),
time velocity (+2), (+3)
integral(LVOT TVI) (0), (+1), (+2), (+3)
(Figs. 1 and 2).
- (Pressure - Volume Loop)
ESPVR
Hewlete - Packard Sonos 1500
apical 4 - chamber view
(real time LV volume)

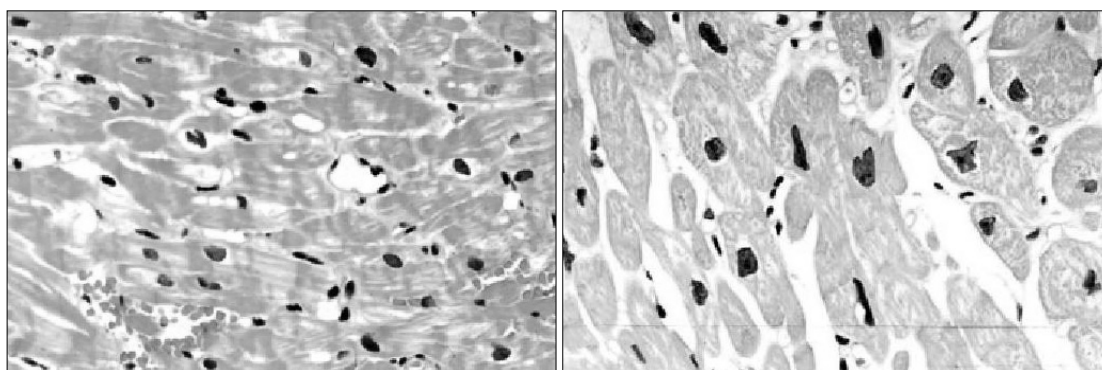


Fig. 1. On the left, mild degree of myocyte hypertrophy change is noted. On the right, severe degree of myocyte hypertrophy change is noted.

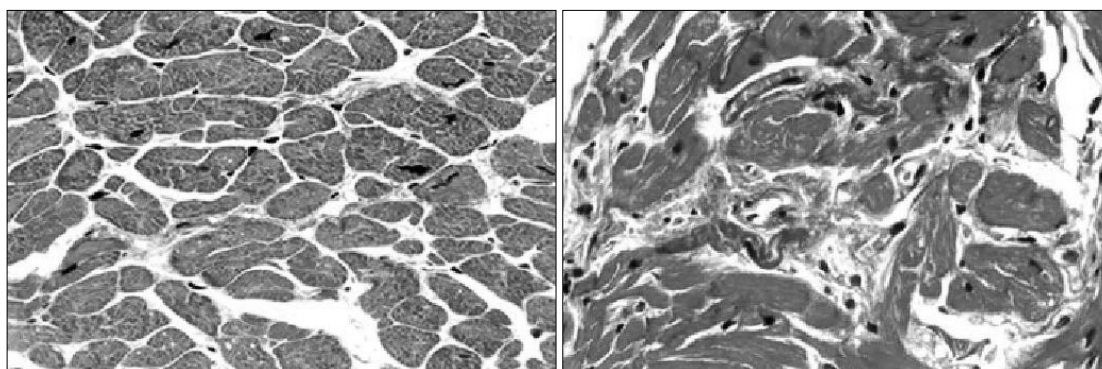


Fig. 2. On the left, mild interstitial fibrosis is noted. On the right, severe degree of interstitial fibrosis is eminent.

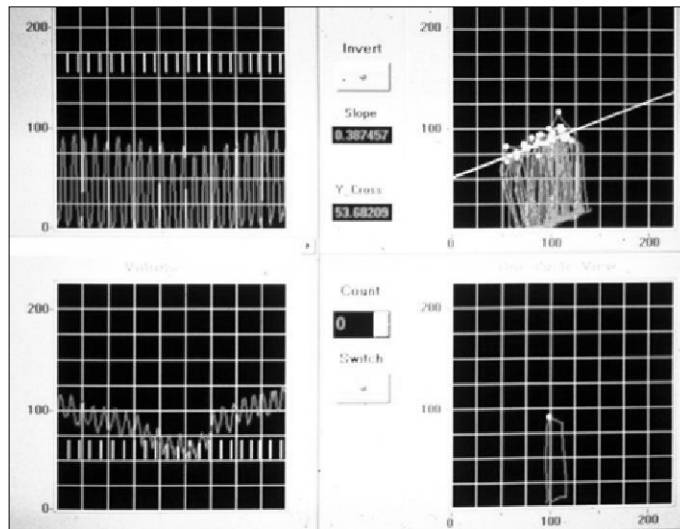


Fig. 3. Generation of multiple pressure-volume loops is depicted with calculation of ESPVR (the straight line connecting left upper corners of the loops) on the right upper portion. The LV volume curves are depicted on the left lower portion and the LV pressure curves on the left upper portion. On the right lower portion, a single pressure-volume is drawn.

(automated edge detection method) 0.05 가 .

(LV volume (LV volume (digiti - zation) 5 F pigtail catheter 14 , 2 가

가 20 mses (digitization) - 1 가 -

- (pressure - volume loop) . 1 dobutamin

(maximum balloon diameter : 3 cm) -

10 가

Table 1 .

Doppler Table 2

5 10 - Table 3

ESPVR (Fig. 3).²³⁾ baseline .

ESPVR dobutamin 10 μ g/Kg/ 이면성 심초음파 검사및 혈액학적 소견과 병리조직학적

min 3 ESPVR (contractility reserve) 검사의 비교

(interstitial fibrosis)

(myocyte hypertrophy) (<2)

자료분석 (2)

± ,

Mann - Whitney p 가 (Table 4 and 5).

Table 1. Clinical profiles and hemodynamic data

Patient	AGE	SEX	BSA	NYHA	MPAP	AoS	AoD	LVEDP	HR
1	63	M	1.38	2	17	140	80	10	80
2	57	F	1.48	4	9	100	70	10	75
3	61	M	1.26	3	26	159	80	20	75
4	41	F	1.86	4	55	120	70	35	75
5	55	M	1.26	3	26	159	80	20	75
6	50	F	1.77	3	24	108	53	23	69
7	64	M	1.67	2	26	163	81	35	90
8	51	F	1.61	2	22	120	78	15	105
9	66	F	1.67	2	21	120	66	25	74
10	39	F	1.71	3	31	103	59	25	75

BSA : body surface area (m²)

NYHA : New York heart association functional class

MPA : mean pulmonary artery pressure (mmHg)

HR : heart rate (beats/min)

AoS : systolic aortic pressure (mmHg)

AoD : diastolic aortic pressure (mmHg)

LVEDP : LV enddiastolic pressure (mmHg)

Table 2. Two dimensional and Doppler echocardiography findings

Patient	DT	E	A	E/A	PVS	PVD	PVA	LVEDD	LVESD	LVEDV	LVESV	SV	LV	EF
1	80	100	30	3.3	24	51	20	72	64	272	209	64	219	21
2	167	62	90	0.7	34	45	27	76	68	307	239	68	262	19
3	160	85	55	1.5	64	49	20	66	55	224	147	76	220	35
4	113	72	21	3.5	53	61	34	69	59	247	173	74	203	27
5	233	48	36	1.3	61	47	18	65	52	216	130	87	283	35
6	210	59	72	0.8	30	31	27	76	66	307	224	84	305	30
7	110	40	69	0.6	28	28	18	72	67	272	231	41	257	18
8	120	88	19	4.7	17	46	31	66	60	224	180	44	272	23
9	133	89	55	1.6	34	58	21	87	74	415	289	126	389	22
10	127	52	16	3.3	25	58	22	66	61	224	187	37	187	14

DT : deceleration time (msec)

E : E velocity (cm/sec)

A : A velocity (cm/sec)

PVS : systolic pulmonary venous flow (cm/sec)

PVD : diastolic pulmonary venous flow (cm/sec)

PVA : atrial reversal flow (cm/sec)

LVEDD : LV enddiastolic dimension (mm)

LVESD : LV ensystolic dimension (mm)

LVEDV : LV enddiastolic volume (cm³)

LVESV : LV endsystolic volume (cm³)

SV : stroke volume (cm³)

LV mass : gm

Table 3. Pathological findings of endomyocardial biopsy

Patient	MH	IF
1	+2	+1
2	+1	+2
3	+3	+2
4	+2	+1
5	+2	+1
6	+1	+1
7	+1	+1
8	+3	+3
9	+2	+1
10	+3	+2

MH : myocyte hypertrophy IF : interstitial fibrosis

+1 : mild +2 : mild moderate +3 : severe

Doppler 심초음파 검사 소견과 병리조직학적 검사의 비교

(interstitial fibrosis)

(myocyte hyoertrophy) (<2)

(2)

가 E

E/A ratio가 가 Doppler

가

(restrictive physiology)

Doppler

가

(Table 6 and 7).

Table 4. Findings of two dimensional echocardiography and hemodynamic data according to the degree of myocyte hypertrophy changes

	Mild (<2, N = 3)	Severe (≥ 2, N = 7)	p-value*
2DE variables			
LVEDD (mm)	74.7 ± 2.31	70.1 ± 7.82	.10
LVESD (mm)	67.0 ± 1.00	60.7 ± 7.06	.09
LVEDV (cm ³)	296 ± 20.3	260 ± 71.1	.11
LVESV (cm ³)	231 ± 7.82	188 ± 51.8	.09
LV mass/BSA (g/1.73 m ²)	167 ± 12.7	159 ± 41.9	.57
Ejection fraction (%)	22.3 ± 6.66	25.6 ± 8.11	.42
Hemodynamic variables			
Stroke vol (cm ³)	52.5 ± 27.2	53.6 ± 17.7	.73
LVEDP (mmHg)	22.7 ± 12.5	22.9 ± 11.1	1.0
MPAP (mmHg)	19.8 ± 9.14	29.4 ± 13.0	.36

* : Mann-Whitney test

Table 5. Findings of two dimensional echocardiography and hemodynamic data according to the degree of interstitial fibrosis

	Mild (<2, N = 6)	Severe (≥ 2, N = 4)	p-value*
2DE variables			
LVEDD (mm)	73.5 ± 7.56	68.5 ± 5.00	.33
LVESD (mm)	63.7 ± 7.50	61.0 ± 5.35	.67
LVEDV (cm ³)	288 ± 69.2	245 ± 41.8	.33
LVESV (cm ³)	209 ± 54.4	188 ± 38.2	.67
LV mass/BSA (g/1.73 m ²)	164 ± 39.7	158 ± 31.8	.52
Ejection fraction (%)	25.7 ± 6.65	23.0 ± 9.42	.59
Hemodynamic variables			
Stroke vol (cm ³)	59.2 ± 19.2	44.5 ± 18.2	.29
LVEDP (mmHg)	26.3 ± 12.2	17.5 ± 6.46	.24
MPAP (mmHg)	29.5 ± 14.0	22.0 ± 9.21	.59

* : Mann-whitney test

Table 6. Findings of Doppler echocardiography data according to the degree of myocyte hypertrophy change

	Mild (<2, N = 3)	Severe (≥ 2, N = 7)	p-value*
DT (msec)	162. ± 50.1	138.1 ± 48.3	.57
E (m/sec)	53.8 ± 12.0	76.4 ± 19.7	.14
A (m/sec)	76.8 ± 11.2	33.1 ± 16.5	.02
E/A ratio	0.70 ± 0.12	2.76 ± 1.26	.02
PVS (cm/sec)	30.8 ± 2.62	39.8 ± 19.2	.73
PVD (cm/sec)	34.6 ± 9.05	53.0 ± 6.02	.02
PVA (cm/sec)	23.9 ± 4.96	23.7 ± 6.06	.91
PVS TVI (cm)	7.81 ± 0.76	9.57 ± 6.91	.73
PVDTVI (cm)	11.6 ± 4.71	10.9 ± 2.60	.91
PVATVI (cm)	2.63 ± 0.91	3.11 ± 1.27	.49

* : Mann-whitney test

ESPVR과 병리조직학적 검사의 비교

(interstitial fibrosis)

(myocyte hyoertrophy)

(<2) (≥ 2)

가 baseline

ESPVR dobutamin 10 µg/Kg/min

ESPVR

가 baseline

ESPVR dobutamin 10 µg/Kg/min

ESPVR

(Table 8 and 9).

Table 7. Findings of Doppler echocardiography data according to the degree of interstitial fibrosis

	Mild (<2, N= 6)	Severe (2, N= 4)	p-value*
DT (msec)	146.7 ± 61.0	143.3 ± 23.4	.67
E (m/sec)	68.1 ± 23.3	72.0 ± 17.6	.83
A (m/sec)	47.0 ± 21.2	44.9 ± 34.8	.67
E/A ratio	1.86 ± 1.25	2.56 ± 1.78	.52
PVS (cm/sec)	38.5 ± 14.9	35.0 ± 20.4	.67
PVD (cm/sec)	45.9 ± 13.8	49.7 ± 5.86	1.0
PVA (cm/sec)	22.9 ± 6.25	25.0 ± 4.65	.29
PVSTVI (cm)	9.98 ± 5.63	7.63 ± 6.39	.20
PVSTVI (cm)	11.4 ± 2.11	10.6 ± 4.56	.39
PVATVI (cm)	3.18 ± 1.37	2.64 ± 0.16	.16

* : Mann-whitney test

Table 8. Values of ESPVR according to the degree of myocyte hypertrophy change

ESPVR**	Mild (<2, N= 3)	Severe (2, N= 7)	p-value*
Baseline			
Downward slope	1.79 ± 0.29	0.91 ± 0.49	.03
Upward slope	2.57 ± 0.60	1.42 ± 0.53	.03
Dobutamin 10 µg/kg/min			
Downward slope	2.68 ± 0.67	1.38 ± 0.85	.05
Upward slope	3.46 ± 0.60	1.95 ± 1.04	.05

* : Mann-Whitney test, ** : mmHg/ml

Table 9. Values of ESPVR according to the degree of interstitial fibrosis

ESPVR**	Mild (<2, N= 6)	Severe (2, N= 4)	p-value*
Baseline			
Downward slope	1.30 ± 0.59	0.98 ± 0.65	.45
Upward slope	1.96 ± 0.65	1.48 ± 0.91	.29
Dobutamin 10 µg/kg/min			
Downward slope	2.07 ± 1.13	1.33 ± 0.62	.29
Upward slope	2.80 ± 1.13	1.81 ± 1.04	.29

* : Mann-Whitney test, ** : mmHg/ml

고 안

가
Vpm, Vmax, dp/dt_{max} isovolumic index
가 2가

가가

가
Sagawa
(time varying elastance model)
(pressure - volume loop)
 $E(t) = P(t)/V(t) - V_d(t)$ E = elastance, P =
, V = , V_d = positive pressure
, t =)
maximum elastance E(t)
Emax
(pressure - volume loop)
(endsystolic pressure - volume re -
lation ESPVR))
ESPVR
Emax ESPVR
Emax ESPVR
ESPVR
(pressure - volume loop)
E - max
28 - 32)
가
가
conductance catheter
33)
radionu -
clide angiography

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dobutamin (baseline) dobutamin 3
(10 µg/Kg/min)
결 론 :
가
가
(restrictive filling
pattern)

가
가
중심 단어 :
감사문

MSD

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