



## Original article

# Slope in preload recruitable stroke work relationship predicts survival after left ventriculoplasty and mitral repair in patients with idiopathic cardiomyopathy



Yasushige Shingu (MD, PhD), Suguru Kubota (MD, PhD), Satoru Wakasa (MD, PhD), Tomonori Ooka (MD, PhD), Hiroki Kato (MD, PhD), Tsuyoshi Tachibana (MD, PhD), Yoshiro Matsui (MD, PhD, FJCC)\*

Department of Cardiovascular and Thoracic Surgery, Hokkaido University Graduate School of Medicine, Sapporo, Japan

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## ABSTRACT

**Background:** Left ventriculoplasty (LVP) and mitral valve plasty (MVP) are sometimes effective for patients with idiopathic dilated cardiomyopathy (DCM) who are not eligible for heart transplantation. Strict patient selection is warranted for these controversial procedures.

**Methods and results:** The subjects were 18 patients with idiopathic DCM and mitral regurgitation who had not been indicated for heart transplantation due to either older age or patient refusal, and who underwent LVP and MVP. Their mean age was  $57 \pm 14$  years and 50% were dependent on catecholamine infusion. The preload recruitable stroke work (PRSW) relationship and its slope (Mw) were estimated by a single-beat technique using transthoracic echocardiography. There were one 30-day mortality and six (33%) hospital deaths due to heart failure. The one-year survival rate was 50%. Left ventricular end-diastolic dimension (LVDD) decreased from  $77 \pm 11$  to  $68 \pm 11$  mm ( $p = 0.001$ ) whereas the ejection fraction did not change. Preoperative Mw was significantly higher in one-year survivors than that in non-survivors ( $54 \pm 17$  erg  $\text{cm}^{-3} 10^3$  vs.  $31 \pm 10$  erg  $\text{cm}^{-3} 10^3$ ,  $p = 0.005$ ). Preoperative LVDD was not different between the groups. The cut-off value of 42 erg  $\text{cm}^{-3} 10^3$  for Mw predicted one-year survival with high sensitivity (100%) and specificity (77%).

**Conclusions:** Mw, the slope in the PRSW relationship, may predict survival after LVP and MVP in patients with idiopathic DCM.

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## Introduction

The surgical strategy for patients with idiopathic dilated cardiomyopathy (DCM) and severe mitral regurgitation (MR) is controversial [1]. MR has a negative impact on the prognosis of patients with heart failure and a very low ejection fraction [2,3]. Mitral valve plasty (MVP) for patients with secondary severe MR and a low ejection fraction (<30%) is recommended in the American Heart Association (AHA) guideline (class IIb) [4]. However, early recurrence of significant MR and heart failure symptoms within 6 months have been reported in patients with

severely dilated left ventricle (LV) after down-sized mitral annuloplasty alone [5]. Thus, procedures in addition to mitral annuloplasty appear to be necessary for the large LV.

To eliminate recurrence of MR and heart failure symptoms in such high-risk patients, some groups, including ours, have developed several submitral procedures such as left ventriculoplasty (LVP) and reported acceptable midterm results [6–15]. Thus far, however, there exist no guidelines that recommend LVP concomitant with MVP, and Batista-type LVP is even a class III recommendation in the AHA guidelines [16]. We performed LV plasty for extremely large heart in 55 cases from 2004 to 2013, and one-year survival rate was 58%. From our experience, we believe this operation has a role in selected patients. Although strict patient selection is important for these controversial procedures, we do not have any reliable LV functional parameters for the prediction of responders to LVP and MVP that we can easily use in clinical practice [17].

\* Corresponding author at: Department of Cardiovascular and Thoracic Surgery, Hokkaido University Graduate School of Medicine, Kita 14, Nishi 7, Kitaku, Sapporo 060-8648, Japan. Tel.: +81 11 716 1161x6041; fax: +81 11 706 7612.

E-mail address: [ymatsui@med.hokudai.ac.jp](mailto:ymatsui@med.hokudai.ac.jp) (Y. Matsui).

We reasoned that load-independent contractile functional parameters would correlate with survival after operation. We demonstrate here that preload recruitable stroke work relationship is useful to predict survival after LVP and MVP in end-stage heart failure patients with idiopathic DCM and severe MR.

## Methods

### Patients' characteristics

Tables 1 and 2 show the patients' preoperative characteristics. The 23 consecutive cases included 18 idiopathic DCM patients with end-stage heart failure who underwent LVP and MVP from 2006 to 2013 (mean age,  $57 \pm 14$  years; 27–77 years). Five patients were excluded from the study due to lack of sufficient echocardiographic data. The diagnosis of DCM was based on the absence of significant coronary artery disease or primary valvular heart disease. The pathological findings of the LV muscle specimens obtained during surgery were also consistent with DCM in all cases. They all had New

York Heart Association (NYHA) class III or IV. Nine (50%) patients were dependent on catecholamine infusion just before operation. Intra-aortic balloon pumping in two patients and percutaneous cardiopulmonary support in one patient were needed just before the operation due to hemodynamic instability. While most patients used beta-blockers preoperatively, the use of angiotensin-converting enzyme inhibitors and angiotensin receptor blockers was relatively rare due to the low blood pressure and renal dysfunction. None of the patients had been registered for heart transplantation due to their age being over 60 years, which was the limited age in Japan at that time, in 11 cases and the patients' refusal in 7 cases. The University Ethics Committee approved the research protocol and informed consent was obtained from the subjects.

### Surgical procedures

To reshape the severely remodeled LV, we performed overlapping LVP without a patch as previously reported [10]. Briefly, we used a 72 ml silicone sizer to remodel the LV to a more ellipsoidal

**Table 1**  
Patients' clinical and echocardiographic characteristics of all 18 idiopathic dilated cardiomyopathy cases.

Age	Gender	NYHA class	CA Dependent	RF (Cr >2.0)	AF	Echocardiographic data					
						LVDd (mm)	LVDs (mm)	LVEF (%)	DcT (ms)	MR grade	Mw (erg cm <sup>-3</sup> 10 <sup>3</sup> )
One-year survivors											
55	Male	3	Yes	No	Yes	88	81	34	135	4	56
67	Male	4	Yes	No	Yes	73	68	23	136	4	28
64	Male	3	No	No	No	80	70	24	144	4	46
60	Female	3	No	No	Yes	82	67	33	212	4	59
37	Male	3	No	No	No	69	54	31	231	4	43
52	Male	3	No	NO	Yes	83	79	21	125	4	41
63	Male	4	Yes	No	No	72	66	28	350	4	67
36	Male	3	Yes	No	No	89	76	40	244	4	88
27	Female	3	No	No	No	57	52	31	108	4	59
Non-survivors											
36	Male	4	Yes	Yes	No	94	87	10	100	3	21
69	Male	3	No	Yes	No	72	69	21	130	4	41
61	Male	4	Yes	No	No	88	85	17	82	4	17
59	Male	4	Yes	yes	Yes	85	74	32	NA	4	44
55	Male	4	Yes	No	No	80	74	24	115	4	33
67	Male	3	Yes	No	Yes	69	59	23	150	4	33
71	Male	4	Yes	Yes	No	62	58	14	120	4	18
77	Female	3	No	Yes	No	74	69	21	158	4	31
64	Male	3	No	No	Yes	73	70	27	96	3	37

AF, atrial fibrillation; CA, catecholamine; DcT, deceleration time; NYHA, New York Heart Association; LVDd, left ventricular end-diastolic dimension; LVDs, left ventricular end-systolic dimension; LVEF, left ventricular ejection fraction; MR, mitral regurgitation; Mw, the slope in the preload recruitable stroke work relationship; NA, not applicable; RF, renal failure.

**Table 2**  
Preoperative characteristics in dilated cardiomyopathy patients.

Variables	Total (n=18)	One-year survivors (n=9)	Non-survivors (n=9)	p-Value
Age	$57 \pm 14$	$51 \pm 14$	$62 \pm 12$	0.08
Male gender	15 (83%)	7	8	1.00
Atrial fibrillation	7 (39%)	4	3	1.00
Diabetes mellitus	5 (28%)	2	3	0.62
Renal dysfunction (serum creatinine >2.0 mg/dl)	5 (28%)	0	5	0.026
NYHA class III/IV	10/8	6/3	4/5	0.64
CRT-D implantation	7 (39%)	2	5	0.15
Catecholamine dependent	9 (50%)	3	6	0.35
Intra-aortic balloon pumping	2 (11%)	0	2	0.47
Percutaneous cardiopulmonary support	1 (6%)	0	1	1.00
Medications				
Amiodarone	11 (61%)	6	5	1.00
Beta blockers	16 (89%)	7	9	0.47
Angiotensin-converting enzyme inhibitors	5 (28%)	2	3	1.00
Angiotensin receptor blockers	7 (39%)	5	2	0.34

Values  $\pm$  standard deviation. CRT-D, cardiac resynchronization therapy-defibrillators; NYHA, New York Heart Association.

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