Clinical characteristics and long-term predictors of persistent left ventricular systolic dysfunction in peripartum cardiomyopathy

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PPCM, peripartum cardiomyopathy; LVSD, left ventricular systolic dysfunction; BNP, brain natriuretic peptide; CRP, C-reactive protein; ROC, receiver-operating characteristic

Brief Summary

Peripartum cardiomyopathy (PPCM), a dilated cardiomyopathy, occurs in women during pregnancy or postpartum with no preexisting cardiac disease. PPCM is defined as cardiac failure due to demonstrable left ventricular systolic dysfunction (LVSD). Initial left ventricular ejection fraction $<34\%$ and brain natriuretic peptide $>1860\text{pg/ml}$ were identified as independent prognostic factors in predicting persistent LVSD and they might have good predictive value in long-term cardiac dysfunction. However, plasma C-reactive protein did not independently predict long-term LVSD.

Abstract

Background: Peripartum cardiomyopathy (PPCM) is a potentially life-threatening dilated cardiomyopathy occurring in previously-well women during pregnancy or postpartum. The predictors of persistent left ventricular systolic dysfunction in PPCM are poorly understood and were the subject of this study.

Methods: Patients with PPCM (n=71), who were admitted to Beijing Friendship Hospital from 2004 to 2011, were retrospectively analyzed. Data including electrocardiogram and echocardiographic measurements at diagnosis (baseline) and the last follow-up visit were collected. Plasma brain natriuretic peptide and C-reactive protein levels were also collected at baseline. A receiver-operating characteristic curve was used to determine the cutoff values. Univariate and multivariate analyses were used to assess the significant predictive variables for persistent LVSD.

Results: Thirty-one (44%) patients did not recover completely at the last follow-up visit (LV non-recovery group), whereas 40 patients (56%) had good left ventricular recovery (LV recovery group). Baseline BNP was positively correlated to left ventricular end-diastolic diameter (LVEDD) ($r=0.559$, $P<0.001$), and inversely correlated to left ventricular ejection fraction (LVEF) ($r=-0.548$, $P<0.001$) and fractional shortening (FS) ($r=-0.542$, $P<0.001$). There was no difference in CRP levels between the two groups. ROC curves indicated the cutoff value in terms of predicting persistent LVSD was 34% for LVEF, 64mm for LVEDD, 16% for FS, and 1860pg/ml for BNP. Univariate and multivariate analyses confirmed that LVEF $<34\%$ [95% CI 1.38-7.30, $p=0.007$] and BNP $>1860\text{pg/ml}$ (95% CI 1.18-6.99, $p=0.020$) were independent prognostic factors in predicting persistent LVSD.

Conclusion: LVEF and plasma BNP levels have good predictive value in long-term cardiac dysfunction.

Keywords: Peripartum cardiomyopathy (PPCM); left ventricular systolic dysfunction (LVSD); prognosis; predictors

Introduction

Peripartum cardiomyopathy (PPCM) is a dilated cardiomyopathy of uncertain origin that occurs in women during pregnancy or postpartum with no preexisting heart disease. According to the criteria for diagnosis established by Demakis ¹ and the National Heart, Lung, and Blood Institute and Office of Rare Diseases of the National Institute of Health ², PPCM can be defined as heart failure due to demonstrable left ventricular systolic dysfunction (LVSD) occurring between the last month of pregnancy and up to five months postpartum. Although this strict timescale has recently been shown to be more variable and many women present with the symptoms of PPCM in early pregnancy ³. The clinical presentation of PPCM differs widely and the rates of recovery of left ventricular (LV) function also differ from 23% to 66% with regard to study size, race, and follow-up duration ⁴. To date, most of the studies pertaining to PPCM have been performed in the United States of America (USA), Haiti, and South Africa and the clinical data are much more limited in the rest of the world including China.

PPCM may lead to serious heart failure, malignant arrhythmias, thromboembolism, and death ⁵. It is important to identify predictors for persistent LVSD in risk stratification and reasonable management strategies ⁶. Although, Fett et al. ⁷ reported that LV echocardiographic features were unable to predict LV recovery in rural Haiti. More recently, studies have reported that lower systolic heart function at diagnosis means less recovery from PPCM ⁸⁻¹³.

It is well known that brain natriuretic peptide (BNP), a biomarker for increased ventricular stretch or wall tension, is a useful clinical predictor of heart failure and has good diagnostic and prognostic value. C-reactive protein (CRP), a simple biomarker for detecting low-grade inflammation, has been shown to be associated with adverse

prognosis in patients with idiopathic dilated cardiomyopathy. However, the prognostic values of BNP and CRP as independent determinants of long-term prognosis in PPCM are not clearly understood.

The present study was aimed to evaluate the predictors of persistent LVSD in women with PPCM in a Chinese population.

Material and methods

Patients (n=71) with PPCM, who were admitted to Beijing Friendship Hospital affiliated to Capital Medical University, China between 2004 and 2011, were retrospectively analyzed. According to both clinical and echocardiographic criteria, PPCM was defined as an occurrence of unexplained heart failure in a healthy women between the last month of pregnancy and up to five months postpartum, with left ventricular ejection fraction (LVEF) below 45% or fractional shortening (FS) less than 30%^{1,2}. Patients who met the diagnostic criteria of PPCM were included in the study. The study exclusion criteria were as follows: (1) significant organic valvular heart disease; (2) diagnosis before pregnancy of systemic hypertension, diabetes mellitus, or thyroid dysfunction; (3) alcohol or cigarette use including smoking before pregnancy and malignancy. Clinical data were obtained from the patients' medical records. All patients were followed up for at least 12 months after diagnosis. All patients had undergone electrocardiogram (ECG) and echocardiographic measurements at baseline (at the time of diagnosis) and the last follow-up visit. Echocardiographic parameters (including LVEF, left ventricular end-diastolic diameter [LVEDD], FS) and ECG parameters (including wide QRS complex, QTc interval, and ST-segment depression) were recorded for statistical analysis. Recovery of LV function was defined as the presence of LVEF $\geq$ 50%. Blood was collected at

baseline to determine BNP, CRP, hemoglobin, albumin, and creatinine levels. LVEF was measured by transthoracic echocardiography using the modified Simpson's rule¹⁴. Standard, two-dimensional, 'M-mode', and Doppler echocardiographic measurements were performed in all patients. Left ventricular internal dimensions at end-diastole and end-systole were measured according to American Society of Echocardiography guidelines.

Hypertension during pregnancy was categorized according to the National High Blood Pressure Education Program Working Group Report on high blood pressure (BP) in pregnancy¹⁵.

The medication the patients received to treat their condition was noted, in particular the use of beta-blockers and the numbers receiving angiotensin-converting enzyme inhibitors as the recommended treatment from the evidence-based guidelines from the American Heart Association/American College of Cardiology and European Society of Cardiology.

This study was approved by the Institutional Review Board of Beijing Friendship Hospital, China. The informed consents from patients were waived.

Statistical analysis

Statistical analysis was performed with the *t* test for parametric values and χ^2 test or Fisher's exact test for nonparametric values. Spearman correlation coefficients were calculated for continuous data. Cutoff values were defined by Receiver-Operating Characteristic curves (ROC curves). P value of <0.05 was considered statistically significant. In univariate and multivariate analyses, Cox proportional hazards regression model was used to assess the capability of the individual variables to predict persistent LVSD. Variables were retained in the Cox model with a Wald *P*

value of <0.05 . Therefore, LVEF, FS, LVEDD, BNP, and CRP were all entered into the multivariate analysis model.

Results

Baseline clinical characteristics

Seventy-one patients were identified with documented diagnosis of PPCM. All of the women were of Chinese Han nationality from central China. The baseline clinical characteristics of the study population are shown in Table 1. The average age at diagnosis was 28 ± 6 years. The majority of patients (68%) had onset of clinical symptoms after delivery. The most common presenting symptoms and signs were dyspnea (89%), peripheral edema (70%), or tachycardia (69%). Thirty-eight (54%) patients had hypertension during pregnancy and 29 of these hypertensive patients had eclampsia or preeclampsia. Fourteen patients (20%) had severe hypoalbuminemia (serum albumin <25 g/L). Other complications associated with PPCM were as follows: pulmonary edema ($n=28$, 39%), acute renal failure ($n=4$, 6%), deep vein thrombosis ($n=2$, 3%), and acute pulmonary embolism ($n=2$, 3%).

Baseline ECG abnormalities were found in 64 patients (90%). All patients had sinus rhythm. T-wave anomalies were the most common abnormalities (56%), followed by $QTc \geq 0.44$ s (47%), and ST-segment depression (27%). The proportion of the patients with QTc of 0.44-0.46s and >0.46 s were 35.2% and 11.3%, respectively. No patients had a prolonged QRS time (>120 ms).

There was only one patient whose plasma BNP level was below 100pg/mL. Similarly, three patients had a plasma CRP level below 8mg/L. There was a positive correlation between baseline BNP and LVEDD ($r=0.559$, $P<0.001$). An inverse correlation was observed between baseline BNP and LVEF ($r=-0.548$, $P<0.001$) or FS

($r=-0.542$, $P<0.001$).

Maternal, obstetrical, and neonatal outcome

Fifty-seven (80%) patients were primiparous and 42 (59%) had premature delivery (<37 weeks). Cesarean section was carried out for 60 patients for cardiac reasons (24/60), obstetrical reasons (18/60), and other reasons (willingness of pregnant women to opt for caesarean, morbidly overweight, and bacteremia or other diseases not related to the cardiac disorder) (18/60). No maternal deaths were observed during follow up. There were 4 stillbirths at 32+1 week, 33 week, 33+3 week and 34+5 week, respectively, and 3 neonatal deaths. The deaths were due to fetal malformation 1 case (congenital heart disease), and neonatal asphyxia two cases. There were also 2 cases of fetal distress and 1 neonatal asphyxia.

The first neonatal asphyxia was supplementary diagnosed as placental abruption and the Apgar score was 2 points after delivery and dead 1 hour later. The second was supplementary diagnosed as premature delivery (32 weeks), and the Apgar score was 3 points after delivery and dead 12 hours later. Another got 6 points of Apgar score and discharged alive.

Comparison between LV recovery group and non-recovery group

Mean follow-up was 43 ± 33 months. Of the 71 patients, 31 (44%) had persistent LVSD at their last follow-up (Table 2). The LV non-recovery group had significantly higher plasma BNP, lower LVEF and FS, and larger LVEDD at baseline. However, there was no significant difference in CRP levels between the two groups.

Medication use on presentation was also compared between the LV recovery and non-recovery groups (Table 2) and there were no significant differences in the use of diuretics ($p=0.861$), angiotensin-converting enzyme inhibitors ($p=0.58$), beta-blockers ($p=0.624$), digoxin ($p=0.703$), or intravenous vasodilators ($p=0.896$).

Predictors of persistent LVSD

In ROC analysis, the area under the curve of LVEF, FS, LVEDD, BNP, and CRP were 0.838 (95% confidence interval [CI] 0.744-0.932), 0.754 (95% CI 0.629-0.878), 0.827 (95% CI 0.732-0.922), 0.853 (95% CI 0.757-0.950), and 0.581 (95% CI 0.447-0.716), respectively (Fig.1-5). The cutoff value in terms of predicting persistent LVSD was 34% for LVEF, 64mm for LVEDD, 16% for FS, 1860pg/ml for BNP, and 21mg/L for CRP at baseline. The sensitivity, specificity, positive predictive value, and negative predictive value of these parameters are shown in Table 3.

Univariate and multivariate analyses confirmed that LVEF <34% (hazard ratio [HR] 3.17, 95% CI 1.38-7.30, $p=0.007$) and BNP >1860pg/ml (HR 2.87, 95% CI 1.18-6.99, $p=0.020$) were independent prognostic factors in predicting persistent LVSD (Table 4).

Comparison of patients with PPCM based on the criteria of hypertension: a sub-group analysis

Thirty-eight patients had hypertension during pregnancy: 24 patients with preeclampsia, 9 with gestational hypertension, and 5 with eclampsia. Twenty patients (53%) required antihypertensive medication at the time of hospital discharge; however, only 4 patients continued antihypertensive medications at the last follow-up. We found no significant differences in echocardiographic between the two groups after ≥ 12 months follow-up (Table S1 in Supplementary materials).

Discussion

The present study provided a clinical profile and the long-term follow-up results of patients with PPCM from a tertiary-level hospital in Beijing, China. Some of the clinical characteristics described in the present study were different from previously

published data. In the present study, LV function was normalized within one year of onset in 56% of the patients. LVEF <34% and BNP >1860pg/ml at baseline were associated with about 3-fold increased risk of persistent LVSD within the long-term follow-up, whereas age, parity, blood pressure, LV dimensions, and plasma CRP levels did not appear to play a role.

We found 80% patients developed PPCM in association with their first pregnancy. This was consistent with 75% found by Elkayam et al.¹⁶ The development of symptoms and diagnosis occurred antepartum in the majority of the patients (68%), which was significantly different from African-American patients (17%) and white women (36%)¹⁷. The rate of cesarean section (85%) in the present study, especially in patients complicated with hypertension (92%), was substantially higher than the reported rate of 36% to 70% in patients with PPCM in other countries and 22%-29% in women with congenital or valvular heart disease^{9, 10, 16, 17}. The common reasons included obstetrical need, presentation of advanced heart failure with hemodynamic instability, and high prevalence of symptoms antepartum and complications. However, more attention needs to be paid to the increasing rate of cesarean sections in all pregnant women that had reached 46.2% in China last year (reported by the World Health Organization).

In this study the rate of hypertension (54%) was higher than other reported values of 25-45% among Caucasians, Nigerians, and Japanese patients¹⁸, and was significantly different from those in South Africa (2%)¹⁶ and Haiti (4%)⁷. Difference in race, lifestyle, and medical standards might be responsible for this. The results also do not support the presumption that increased blood pressure is causative in the development of PPCM, although it is possible that the hypertensive state and PPCM are associated with other common cardiovascular risk factors. It is reasonable to

consider that these patients were suffering from cardiomyopathy and hypertension and they might prone to heart failure in the acute stage.

The worldwide data on prognosis of patients with PPCM have been conflicting and appears to vary geographically, mortality rates vary from 0 to 30%¹⁹. In the USA it ranges from 0% to 3.3% or slightly higher^{19,20}, whereas the 6-month PPCM maternal mortality rates in Brazil²¹ and Haiti²² are 14–16%. Goland S et al.¹¹ have reported a mortality rate of 30% over 4-year follow-up in a single tertiary hospital from Turkey. There was no maternal death in this study possibly because of racial difference, relatively low occurrence of life threatening complications including acute renal failure (6%), deep vein thrombosis (3%), and acute pulmonary embolism (3%), prompt treatment with angiotensin converting enzyme inhibitor and beta-blockers, and a collaborative team of physicians (comprising cardiologist, obstetrician, anesthesiologist, neonatologist, and intensive care physician). Another Chinese study²³ described a mortality rate of 1.9% in 52 patients with PPCM. The medication used in the treatment of the affected patients in that study was similar to this one, but the rate of use was apparently higher with digoxin being administered to 50% of the women²³. Severe complications have often been reported in PPCM, which accounts for high mortality rates^{11,24}.

In previous studies, a complete LV recovery rate of 44% was reported over an average follow-up period of 43 months, whereas only 24% patients improved completely in the Turkish population¹⁰ and 21% in South African patients²⁵. More recently LV recovery rates have improved, probably because of better understanding of PPCM and its treatment. A prospective study from Turkey in 2012 showed a recovery rate of 48%¹⁷. While a study that compared outcomes between African Americans and white patients in 2013 showed higher rates for the white population

(61%) and a lower rate in African Americans (40%)²⁶. The rate in our study was 56% which we consider to be fairly comparable to the best of the recent rates at 60%. Some confounding factors cannot be avoided in a retrospective study, and there will be influences due to racial differences, a poor obedience and unauthorized stopping of medicine that may lower the recovery rate. An up-to-date assessment of the appropriate medications should be considered by treating physicians. Although we saw no significant differences between the recovery and non-recovery groups in terms of medication use, higher recovery rates of up to 78% have been seen in studies where the use of beta-blockers and angiotensin converting enzyme inhibitors have approached 100%,^{27, 28} much higher than the rates in our study of approximately 50% and 65-70%, respectively. Current guidelines suggest the use of tolerable doses of both types of medication to treat heart failure with reduced LVEF, as the data from our study included patients treated 10 years ago the medication rates are likely to be lower than those used to treat more recent patients so this may have impacted upon the recovery rates in this study. The rate of digoxin use may also be of some concern, as it is not a class I recommendation for recovery of heart function after reduced LVEF, although in this study it was used to control underlying syndromes, but not for curing heart dysfunction.

We found that initial BNP level was positively correlated with the severity of LV dysfunction, and only BNP and LVEF at baseline were independent long-term predictors of LV recovery. Echocardiography is an important tool for severity of cardiac dysfunction evaluation; however, conflicting echocardiography findings have been reported in different patient population. Duran et al.¹⁰ determined that cutoff values for initial LVEF >27% and LV end-systolic diameter (LVESD) ≤55mm may help to predict the recovery of LV function in Turkish population. The risk of major

adverse events was more common in women with lower LVEF ($\leq 25\%$) in non-Caucasian patients¹¹. Chapa et al.¹² reported that FS $< 20\%$ and LVEDD $\geq 60\text{mm}$ at diagnosis were associated with a more than 3-fold higher risk for persistent LVSD in Chicago patients. However, Amos et al.²⁰ found that the recovery of LV function was not predicted by the initial ejection fraction in American patient population. The patients in this study with baseline LVEF $< 34\%$ were > 3 -fold more likely to have persistent impairment of cardiac function.

BNP is elevated in both asymptomatic and symptomatic LVSD, with its increasing proportion related to the severity of chronic heart failure²⁹. The normal value of BNP in healthy pregnant women is less than 100pg/ml ³⁰. Only a few studies describe the significance of admission BNP levels in patients with PPCM after a long-term (≥ 12 months) follow-up. Given that BNP levels do not significantly fluctuate during normal pregnancy or postpartum³¹, it is hypothesized that an early measurement of this marker should be useful for risk stratification of PPCM. We confirmed the predictive value of BNP. This may be explained in two ways. Firstly, blood volume (preload), LVEDD, and cardiac output increase during pregnancy results in increased ventricular wall stretch and LV pressure. Maladaptive response to these hemodynamic stresses may cause a temporary LV dysfunction and subsequent release of BNP. Secondly, increased BNP levels may result from a previous myocardial injury and ongoing deterioration of LV function.

In prognostic and diagnostic research, CRP cutoff values of 10 and 100 mg/L , respectively, have been used in different cardiopulmonary diseases. However, most of the patients had raised levels of CRP reflecting the inflammatory response involved in the development of PPCM. This result is similar to other studies that have also found a raised level of CRP in patients with PPCM, and one study suggests that CRP levels

can be used as a predictor of mortality³². Plasma CRP did not independently predict the long-term LVSD, possibly because of many other critical conditions (infection and hypertension) occurring in both groups may also have caused the elevated levels of CRP. So there is a suggestion that CRP may have potential as a non-specific biomarker for monitoring treatment of PPCM, but this needs to be explored in greater depth than in the current study. Further prospective evaluation of its value in larger cohorts is now warranted.

This study has some limitations. Although a relatively large series of patients with PPCM were retrospectively analyzed, the sample size was small because of the rarity of PPCM, and some observations might have limited statistical power. The retrospective data were collected from medical reports of patients, and the echocardiographic findings were provided by different physicians. In addition, complete data of pharmacological treatment for some patients were not available because of the long follow-up period. The study cannot provide an explanation for the differential racial outcomes, which are likely to be multifactorial, including potential genetic and physiologic variances as well as possible differences in health care system.

In conclusion, lower LVEF (<34%) and higher plasma BNP concentrations (>1860 pg/ml) were identified as independent prognostic factors in predicting persistent LV dysfunction in PPCM. Our study reinforces the idea that there are differences in clinical characteristics and prognosis of patients with PPCM among different international locations. Hence, it is extremely important to characterize the geographical, ethnic, genetic and racial determinants of PPCM presentation and prognosis. Multicenter, prospective, population-based studies are required in China and elsewhere to understand better the etiology, pathophysiology, and prognosis of

PPCM.

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Disclosure:

The authors declare that they have no conflict of interest.

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Tables

Table 1 Baseline characteristics of patients with PPCM (n=71)

	Mean±SD or number (%)
Age, years	28±6
Gravidity	1.9±1.2
Primiparous	57 (80%)
Hypertension	38 (54%)
Premature delivery	42 (59%)
Caesarean Section	60 (85%)
Onset of clinical symptoms antepartum	48 (68%)
Systolic blood pressure, mmHg	139.6±26.7
Diastolic blood pressure, mmHg	89.6±18.4
ECG parameters	
QRS, ms	80.2±22.8
QTc, s	0.44±0.05
ST-segment depression	19 (27%)
LVEF, %	36.1±6.6
LVEDD, mm	60.7±5.2
FS, %	18.4±3.9
Anemia	32 (45%)
Proteinuria	38 (54%)
Albumin, g/L	29.3±5.7
Creatinine, µmol/L	95.1±121.4
CRP, g/L	31.5±22.1
BNP, pg/mL	1583.5±1510.2

PPCM, peripartum cardiomyopathy; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end diastolic dimension; FS, fractional shortening; CRP, C-reactive protein; BNP, brain natriuretic peptide; ECG, electrocardiogram

Table 2 Comparison between patients with (recovery group) and without left ventricular recovery (non-recovery group)

	Recovery group (n=40)	Non-recovery group (n=31)	<i>p</i> value
Age, years	29±5	28±6	0.497
Age >30years	17 (43%)	10 (32%)	0.378
Gravidity	2.0±1.4	1.8±0.9	0.475
Primiparous	33 (83%)	24 (77%)	0.594
Hypertension	20 (50%)	18 (58%)	0.499
Premature delivery	21 (53%)	21 (68%)	0.195
Caesarean Section	33 (83%)	27 (87%)	0.595
Eclampsia/preeclampsia	14 (35%)	15 (48%)	0.255
ECG parameters			
QRS, ms	78.6±20.8	80.1±21.8	0.532
QTc, s	0.44±0.03	0.43±0.03	0.194
ST-segment depression	8 (20%)	11 (35%)	0.144
LVEF at baseline, %	39.5±4.4	31.6±6.3	<0.001
Last LVEF, %	58.7±5.0	42.5±5.3	<0.001
LVEDD at baseline, mm	58.2±3.7	64.0±4.9	0.001
Last LVEDD, mm	52.4±3.7	59.8±4.7	<0.001
FS at baseline, %	19.9±3.0	16.4±4.1	0.006
Last FS, %	34.1±2.6	23.2±4.0	0.001
Anemia	16 (40%)	16 (52%)	0.329
Proteinuria	21 (53%)	17 (55%)	0.329
Creatinine, µmol/L	81.6±72.8	112.5±164.2	0.335
CRP, mg/L	30.9±25.4	32.3±17.3	0.780
0-10mg/L	7 (17%)	3 (10%)	0.496
11-100mg/L	32 (80%)	28 (90%)	
>100mg/L	1 (3%)	0	
Plasma BNP, pg/mL	727.3±633.5	26887.3±1600.3	<0.001
0-100pg/ml	1 (3%)	0	<0.001
101-1000pg/ml	28 (70%)	7 (23%)	
>1000pg/ml	11 (27%)	24 (77%)	
Medication			
Diuretics	15 (37.5%)	11 (35.5%)	0.861
ACEI	22 (55%)	15 (48.4%)	0.580
Beta-blockers	28 (70%)	20 (64.5%)	0.624
Digoxin	10 (25%)	9 (29%)	0.703
Intravenous vasodilators	6 (15%)	5 (16.1%)	0.896

ECG, electrocardiogram; LVEF, left ventricular ejection fraction; LVEDD, left

ventricular end diastolic dimension; FS, fractional shortening; CRP, C-reactive protein;

BNP, brain natriuretic peptide; ACEI, angiotensin converting enzyme inhibitor

Table 3 Sensitivity, specificity, PPV, and NPV of LVEF, FS, LVEDD, BNP, and CRP in predicting persistent left ventricular systolic dysfunction

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
LVEF<34%	67.7	90.0	84.0	78.3
FS<16%	58.1	90.0	81.8	92.3
LVEDD>64mm	54.8	97.5	94.7	75.0
BNP>1860pg/ml	74.2	95.0	92.0	82.6
CRP>21pg/ml	71.0	50.0	52.3	70.0

LVEF, left ventricular ejection fraction; FS, fractional shortening; LVEDD, left ventricular end diastolic dimension; CRP, C-reactive protein; BNP, brain natriuretic peptide; PPV, positive predictive value; NPV, negative predictive value

Table 4 Univariate and multivariate analyses of predictors of persistent left ventricular systolic dysfunction in patients with PPCM

	Univariate analysis			Multivariate analysis		
	HR	(95% CI)	<i>p</i> value	HR	(95% CI)	<i>p</i> value
LVEF<34%	5	(2.34-10.68)	<0.001	3.17	(1.38-7.30)	0.007
FS<16%	3.31	(1.61-6.80)	0.001	0.57	(0.15-2.09)	0.396
LVEDD>64mm	3.82	(1.86-7.85)	<0.001	1.394	(0.586-3.316)	0.452
BNP>1860pg/ml	4.74	(2.11-10.63)	<0.001	2.87	(1.18-6.99)	0.020
CRP>21pg/ml	1.88	(0.86-4.08)	0.113	0.792	(0.326-1.927)	0.608

PPCM, peripartum cardiomyopathy; LVEF, left ventricular ejection fraction; FS, fractional shortening; LVEDD, left ventricular end diastolic dimension; CRP, C-reactive protein; BNP, brain natriuretic peptide; HR, hazard ratio

Figure Legends

Fig. 1 Receiver-operating characteristic curves for prediction of persistent left ventricular systolic dysfunction by left ventricular ejection fraction, fractional shorting, left ventricular end diastolic dimension, brain natriuretic peptides and C-reactive protein.

Figure 1