Dynamic Change in the Mitral Valve Tenting as a Predictor of the Long-Term Prognosis in Patients With Decompensated Heart Failure

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Abstract

Background. The influence of functional MR over the long-term prognosis in decompensated CHF is unclear. We investigated whether the dynamic changes in degree of mitral regurgitation (MR) and mitral valve tenting during intensive therapy using two-dimensional echocardiography influence long-term prognosis in decompensated congestive heart failure (CHF).

Methods. Forty patients who were admitted to our hospital for exacerbation of CHF were studied. Two-dimensional echocardiographic examinations were performed on admission and at discharge. Thirty eight patients who showed MR on admission were divided into two groups: MR responder, 31 patients with MR reduction during therapy; MR non-responder, 7 patients without MR reduction during therapy. The forty patients were also divided into two groups according to the tenting area: Tenting responder, 21 patients with tenting area reduction during therapy; Tenting non-responder, 19 patients without tenting area reduction during therapy. The long-term event rates of CHF and mortality rates were evaluated and compared by Kaplan-Meier method. Average follow-up period was 803 ± 461 days.

Results. Incidence of recurrent CHF was significantly lower in MR responder than MR non-responder (15/31 vs. 6/7, p=0.017) and also significantly lower in Tenting responder than Tenting non-responder (8/21 vs. 15/19, p=0.005). Mortality rate was significantly lower in Tenting responder than Tenting non-responder (6/21 vs. 15/19, p=0.004).

Conclusions. Reduction of mitral valve tenting area during intensive therapy predicted a good long-term prognosis of decompensated CHF.

Key words: functional mitral regurgitation, mitral valve tenting, congestive heart failure

Introduction

Functional mitral regurgitation (MR) is frequently observed in patients with congestive heart failure (CHF) [1]. Functional MR results from left ventricular (LV) remodeling such as dilatation or distortion, which displaces the papillary muscles and then tethers the mitral leaflets, restricting leaflet coaptation [2-4]. It has been well known that functional MR is a poor prognostic predictor in patients with LV dysfunction [1, 5, 6]. However, the influence of functional MR which is observed in patients with decompensated heart failure over the long-term prognosis is unclear. The degree of MR can decrease during intensive medical therapy [7-9]. Thus, we hypothesized that the decrease of functional MR and mitral valve tenting, which is a main mechanism of functional MR during medical therapy, could influence the prognosis of CHF.

Methods

Patients

The study population was identified from a retrospective database of 189 consecutive patients who were admitted to our hospital for worsening of congestive heart failure from January of 2002 to February of 2004. Of these 189 patients, complete two dimensional and Doppler echocardiograms were digitally stored on
admission and at discharge in 51 patients. Patients with congenital heart disease, prosthetic valves, and structural mitral valve lesions such as mitral valve prolapse or rheumatic disease were excluded. We failed to follow-up on the outcome of 3 patients. In this manner, a cohort of 40 patients (26 male, 14 female, 73 ± 9 years old) was identified. CHF was secondary to coronary artery disease in 9 patients, dilated cardiomyopathy in 10 patients, hypertensive heart disease in 10 patients, valvular heart disease in 7 patients (aortic stenosis in 3 patients, aortic regurgitation in 3 patients and aortic stenosis and regurgitation in 1 patient) and unknown etiology in 4 patients. Pharmacologic treatment included diuretics, inotropic drugs, vasoactive drugs, beta-blockers and antiarrhythmic drugs. None of the patients underwent nonpharmacological treatment. Thirty-eight patients showed MR on admission. Average hospitalization length was 28 ± 17 days. Mortality and recurrent CHF were determined by chart review or family interviews. 

Echocardiography

All echocardiographic studies were performed on admission and at discharge, including measurements of LV end-diastolic diameter (LVDd), LV end-systolic diameter (LVDs), LV end-diastolic volume (LVEDV), LV end-systolic volume (LVESV) and LV ejection fraction (LVEF). MR was semi-quantitatively assessed by measuring the jet area of color-flow Doppler in parasternal long axis view on admission (MRad) and at discharge (MRdis) retrospectively. Tenting area was also measured retrospectively by the area enclosed between annular plane and mitral leaflet in parasternal long axis view at mid-systole on admission (TAad) and at discharge (TAdis). Changes between MRad and MRdis (ΔMR=MRad-MRdis), changes between TAad and TAdis (ΔTA=TAad-TAdis) and changes in LVEF (ΔEF) between EF on admission (EFad) and EF at discharge (EFdis) were calculated (ΔEF=EFdis-EFad).

Patients who showed MR on admission were divided into two groups: MR responder (ΔMR>0), consisting of 31 patients who showed a reduction of MR during hospitalization; and MR non-responder (ΔMR≤0), 7 patients who did not show a reduction of MR during hospitalization. Patients were also divided into two groups according to the tenting area: Tenting responder (ΔTA>0), 21 patients who showed a reduction of tenting area during hospitalization; and Tenting non-responder (ΔTA≤0), 19 patients who did not show a reduction of tenting area during hospitalization.

Intra- and interobserver variabilities

Intra- and interobserver variabilities were investigated for the reliability of tenting area measurements. Two independent observers studied 10 randomly selected patients for interobserver variation, and one observer repeated the observation in the same cohort of 10 patients on different days to assess the intraobserver variation.

Statistical analysis

Data are expressed as mean ± SD. Group comparisons used Student’s t test. A value of p<0.05 was considered statistically significant. Cox proportional hazards models were constructed to assess univariate association with survival. The long-term event rates of CHF and mortality rate were evaluated and compared by the Kaplan Meier method. Relationship between variables was assessed by simple regression analysis. Study protocol was approved by the Committee for the Protection of Human Subjects in Research at Kawasaki Medical School.

Results

Variables from echocardiography

In table 1, measurements of LV chamber are summarized. MR jet area decreased and LVEF improved after therapy. Tenting area, LVDd, LVDs, EDV and ESV tended to improve during therapy but were not statistically significant.
Long-term prognosis

Twenty-one patients died during the follow-up period. The causes of death were heart failure (12 patients), sudden cardiopulmonary arrest (2 patients), intestinal hemorrhage (2 patients), malignant tumor, acute myocardial infarction, ischemic colitis, sepsis, and cerebral hemorrhage (1 patient each). Cumulative survival rates are 75%, 63%, 51% and 38% at 1, 2, 3 and 4 years, respectively.

Univariate association with survival

Cox proportional hazards univariate analysis showed $\Delta TA > 0$ (p=0.007) as a strong predictor of mortality (Table 2). Neither $\Delta EF > 0$ nor $\Delta MR > 0$ were significant.

Comparison in the mortality by Kaplan-Meier method

Kaplan-Meier analysis showed the mortality rate was significantly lower in Tenting responder compared with Tenting non-responder (6/21 vs. 15/19, p=0.004, Figure 1D). The mortality rate tended to be lower in MR responder than in MR non-responder, but it was not statistically significant (15/31 vs. 5/7, p=0.144, Figure 1B).

MR jet area, tenting area and ESV

MR jet area was proportional to tenting area both on admission (p=0.003) and at discharge (p=0.032). Tenting area was significantly proportional to ESV both on admission (p<0.001) and at discharge (p<0.001).

Intra- and interobserver variabilities

For intraobserver variation, the average difference in measurements of tenting area was 0.03 cm$^2$ (r=0.92). The average difference in interobserver was 0.03 cm$^2$ (r=0.88) for tenting area.

Discussion

In the present study, Kaplan-Meier analysis revealed that a reduction of the tenting area during intensive therapy predicted a better prognosis in patients with CHF. To our knowledge, this is the first report that showed changes in tenting area during therapy as a predictor of long-term prognosis in decompensated CHF.

Previous studies have investigated the predictors of long-term prognosis in heart failure patients [1, 5, 10-14]. Pocock et al. reported in their study of a large CHF population that older age, diabetes, and lower
LVEF were the three most powerful predictors of cardiac death and/or heart failure hospitalization [11]. They also mentioned MR as one of the further independent and highly significant predictors. Robbins et al. has shown that age, left atrial dimension, tricuspid regurgitation grade, moderate to severe MR, LVEF, and LVDs were significant univariate predictors of mortality in chronic heart failure patients who have LVEF \( \leq 40\% \) [1]. These study populations include various causes of heart failure. The predictors of the outcome of CHF would depend on the etiology of CHF. In the chronic phase after myocardial infarction, it has been well-known that the incident of CHF and mortality are related directly to the degree of ischemic MR [5, 12]. A study of dilated cardiomyopathy has reported that LVEF and systolic blood pressure were independent predictors of long term mortality [13]. In patients with hypertrophic cardiomyopathy and hypertensive cardiomyopathy, history of myocardial infarction, atrial fibrillation on ECG and mitral annular calcification have been reported as predictors of prognosis [14]. In valvular disease, symptoms, LVEF, LVDs or ESV are universally accepted as predictors [15-20].

In the present study, LVDs, ESV and LVEF were not significant as predictors of long-term prognosis. This discrepancy between the present study and previous studies might be due to the following: a diversity of underlying diseases which caused CHF, a relatively small number of study population, and a difference of timing of echocardiography. While the previous studies have studied the data of echocardiography in stable or chronic phase, we studied the acute phase of CHF and just after intensive therapy and compared these parameters in a relatively short period.

Functional MR mainly results from mitral tethering, and change in MR jet area should show the same result as tenting area. However, in the present study, change in tenting area during therapy predicted recurrence of CHF and mortality stronger than that in MR jet area. Although MR jet area was proportional to tenting area on admission in this population, the correlation coefficient between MR jet area and tenting area

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**Fig. 1.** CHF free survival and survival rate

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![Image of survival rate graphs](image-url)
at discharge was poorer than that in admission. Interestingly, some patients did not show significant MR despite the large tenting area at the time of discharge. This may be attributed to the mitral apparatus morphology, and further investigation of the relationship between functional MR and valve geometry is needed in this regard.

LVEF, ESV, and tenting area are parameters that are closely related to each other. In the present study, tenting area was significantly proportional to ESV both on admission and at discharge. Table 1 shows better improvement of ESV during therapy compared to EDV, and it contributes to the improvement of LVEF. However, change in tenting area during therapy predicted long-term prognosis of CHF patients stronger than change in EF. This may be because tenting area reflects not only LV remodeling but also other factors such as enlargement of left atrium with annular dilatation.

**Study limitations**

1) This study population includes 4 kinds of etiology of CHF: ischemic heart disease, dilated cardiomyopathy, hypertensive heart disease, and valvular disease. Various pharmacologic treatments were selected according to degrees of fluid overload and reduced cardiac output. There could be geometric differences in the mitral apparatus in various types of etiologies. 2) This present study includes 40 patients, a relatively small study population. Larger number of patients should be studied.

**Conclusion**

Reduction of mitral tenting area during intensive therapy predicted a good long-term prognosis in patients with decompensated CHF.

**References**

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